AL/AO-TR-1996-0003

AIR FORCE DENTAL FACILITY DESIGN GUIDANCE (AFDFDG)

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January 1996

Interim Technical Report

Approved for public release; distribution is unlimited.

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The Office of Public Affairs has reviewed this technical report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

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Project Architect/Engineer

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Chief, Clinical Sciences Division

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13. ABSTRACT *(Maximum 200 words)*

This design guidance includes total USAF Dental Clinic facility space planning, construction criteria, and medical gases specifications inclusive of architectural, mechanical, and electrical design requirements. This design guidance also provides space planning for administrative areas, patient waiting and toilets, dental treatment rooms, sterilization areas, professional work areas, consultation offices, prosthodontic laboratories, staff lockers and toilets, dental supply and miscellaneous storage spaces.

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List of Room Names with Line Numbers and Room Codes

*The Line Numbers (Line No.) shown are taken from facility programs for design as provided by the Defense Medical Facilities Office (DMFO) from their standard room function listings, which are used during the initial stages of dental clinic project design program development. Since each individual project may have special design considerations, their facility program for design line numbers may not always be the same as shown above.

**The Room Codes shown are taken from MIL-HDBK-1191, DOD Medical and Dental Treatment Facilities Design and Construction Guide, Appendix A, Architectural and Engineering Design Requirements. This guidance, which includes all architectural, mechanical, and electrical medical facility design requirements, shall be used by all project designers and architectural-engineering (A-E) firms.

Introduction To
Air Force Dental Facility Design Guidance (AFDFDG)
Design Concepts

The standard Air Force dental facility plans are compact, symmetrical, simple designs with adequate space (within DOD criteria) for the specialized functions within. Although intentionally austere in basic design, the interior of these facilities maximize functional relationships for high productivity and significantly reduce initial construction and maintenance costs. These standard plans are definitive designs. In order to achieve the economic and functional advantages of standardized designs, the whole concept of the design must be precisely followed within the limits of site conditions.

Floors. All floors in the standard facility may be either suspended structure or slab-on-grade. A crawl space is preferred; however, if a slab on grade is used, a concrete encased utility trench is recommended to contain the utilities that run from their distribution locations over to the Utility Centers in the floor of the dental treatment rooms (DTRs) at the dental patient chair locations.

Plumbing. Under-floor plumbing is limited to Utility Center High Volumn Oral Evacuation (HVE) and soil pipe (waste) trunk lines with appropriately located clean-outs. All other plumbing (air, water and gas) are run in the overhead (attic) space with risers dropped to using locations and distribution points. Drawing (DWG) NO. 7, 8, and 9 of this material is explicit on standard DTR plumbing. Sufficient utilities are properly located in the DTRs to support any presently available and conceivable future concepts of dental treatment delivery.

Interior. As shown on the attached Dental Clinic/Facility Space Relationship Diagram, the standard facility design is based on three distinct zones of function: administrative, treatment, and support; progressing from the front or main entry to the rear of the facility. The functions of the zones cannot be intermixed. The components making up the administration zone are designed so that whole component locations can be moved within the zone to improve front or main entrance location as predicted by site conditions. Care must be exercised, however, so that the records/reception and lobby waiting components are located as near as possible to the entry into the Service suite to maintain proper patient flow with minimal supervised direction. The treatment zone is basically definitive in scope and component relationship, and only minor allowance for change should be incorporated. Basically, the Dental Instrument Processing Center (DIPC), Xray Suite, and the Department Specialty Office should be arranged in centralized locations for easy and immediate accessibility to and from all Dental Suites. The DTR Support Room(s) and the Professional Work Area(s) (PWAs) should be centralized within each Dental Suite for easy and immediate accessibility. The support zone is basically definitive in scope and component relationship, except for the ability to be widened to increase mechanical room space when required. Support zone width should always be the minimal possible for feasible laboratory and locker/toilet layout.

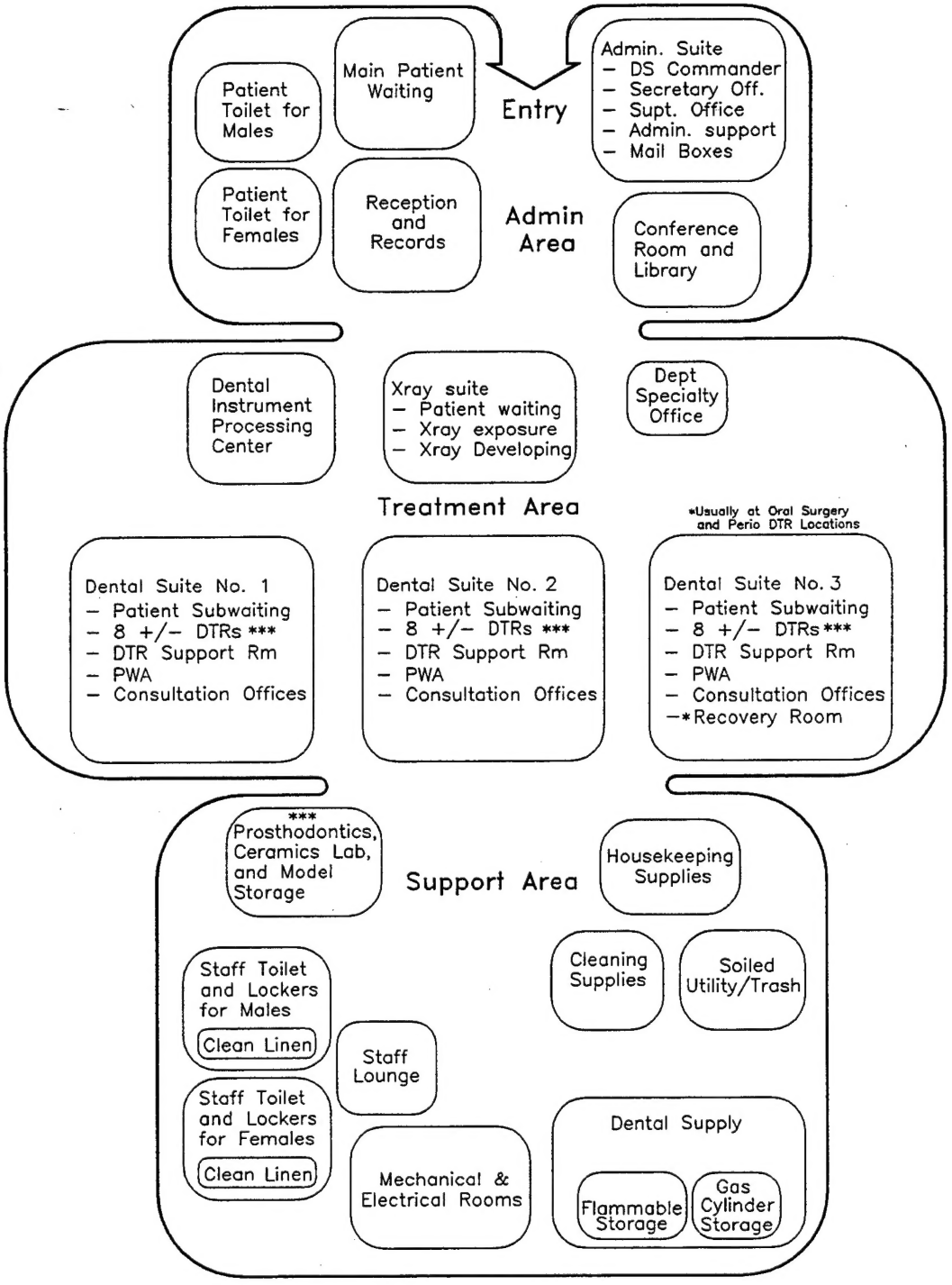
Architecture and Structure. The architecture and structure must comply with the simple, compact, standard design concept and be constructed to business-occupancy codes. Building materials must be selected for simplicity, economy, minimal maintenance and energy conservation. The exterior fascade must be designed for maximum unobtrusive blending into the site environment.

Mechanical Room. Site permitting, the mechanical room should be excavated to provide a single-level roof for the entire structure, simplifying roof frame design and reducing associated cost. The lowered floor of the excavated mechanical space also permits direct entry of effluents from various vacuum systems into their separators without loss of performance from excessive lifting. This feature will allow the use of smaller, more energy conservative system vacuum generators.

Expandability. All standard facilities should be expansible designs. An additional suite of DTRs could be added to either side of the structure, although expansion on the side adjoining the mechanical space may be added without generating asymmetry in the basic structure.

Fenestration. Windows in all DTRs are important for psychological patient control; natural light augmentation of color-corrected artificial light; and alleviation of operator eye fatigue. The practitioner operates for eight hours per day at close hand-eye coordinated tasks at focal distances between 14 and 18 inches. A periodic distant gaze more than that allowed by the confines of the DTR is necessary to prevent optically induced headaches, damaging eye strain and lowered productivity. Windows located in outside walls for all outside-wall-DTRs, the ceramics and prosthodontic laboratories, should not be tinted or shaded in any manner which would inhibit any portion of the visible light spectrum including near-ultra-violet and infra-red. These areas are used for critical shade-matching and any inhibition of the natural light spectrum will produce a light of inadequate color-rendering index (CRI) to permit accurate color selection in clinical and laboratory procedures requiring matching of subtle shades. It is strongly recommended that roof overhang or slated window blinds be utilized to shade these windows during morning and early afternoon hours in warmer geographic areas to minimize solar gain. Windows in other outside walls (building front) may be tinted or shaded as required for energy purposes.

**Dental Clinic/Facility Space Relationship Diagram



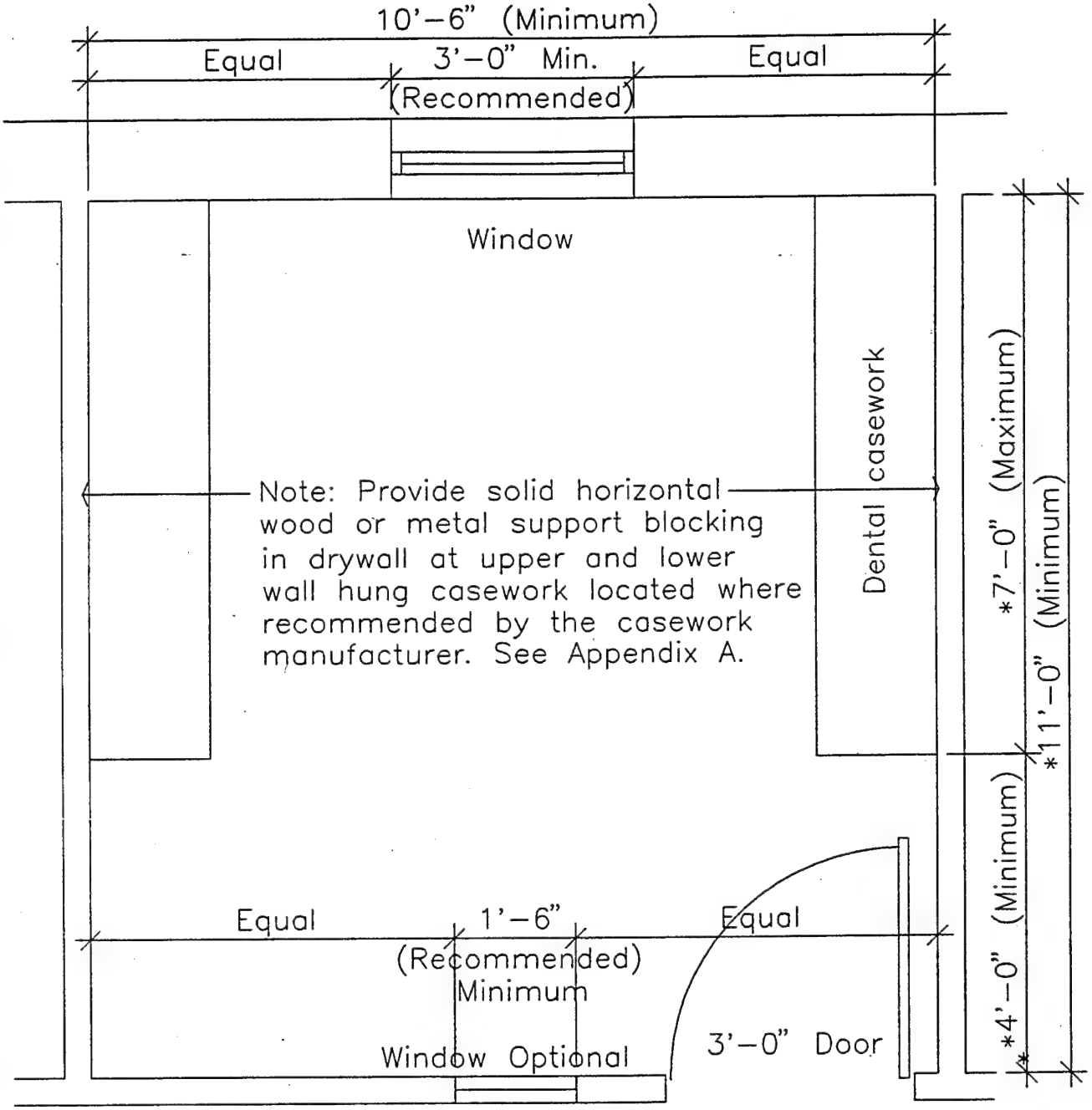
** Space functions shown are NSF requirements that are allowed by DOD Medical Space Planning criteria – Dental Clinics. Gross SF allowed shall be calculated as per MIL–HDBK–1191, to include facility exterior walls, interior partitions, corridors/flow space, mechanical space (both facility and dental), Dental Clinic space functions as shown above, and other miscellaneous building functional space requirements.

***The Prosthodontics DTR(s), and the Dental Suite in which they are located, should be placed in near proximity to the Prosthodontics and Ceramics Lab.

Part I

Standard Basic Dental Treatment Rooms (DTRs) for the Following Disciplines

Standard (General)
Oral Surgery
Prosthodontic
Endodontic
Specialist (Comprehensive)
Preventative (Oral Hygiene)
Periodontic
Orthodontic
Pedodontic
Training

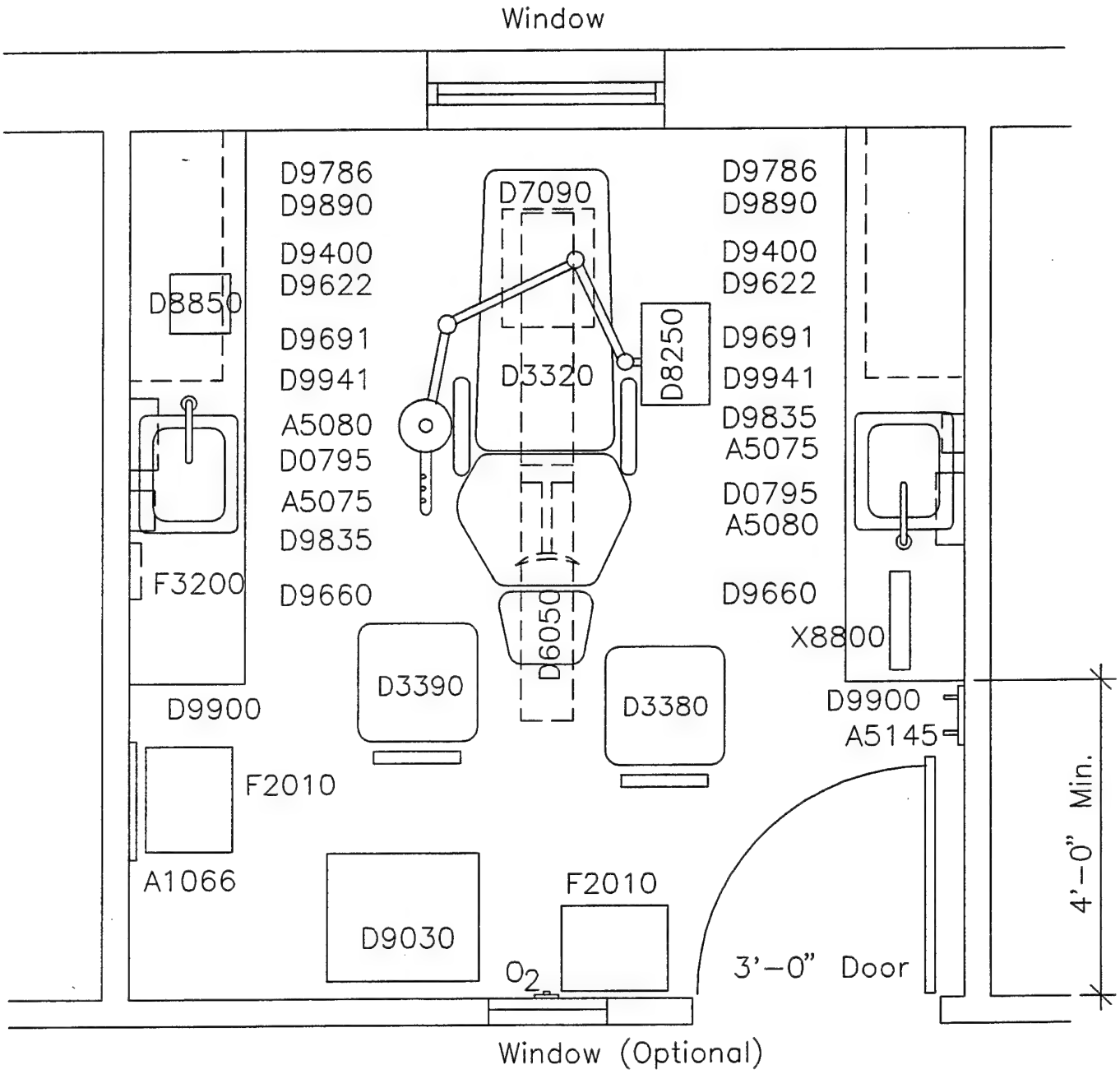


Standard (General) DTR Floor Plan

Scale: 1/2"=1'–0"

*To meet the American Disibilities Act (ADA) and the Uniform Federal Accessilibity Standards (UFAS), the following design criteria shall be met: Dental casework length shall not exceed 7'–0" unless room depth is greater than 11'–0" so as to allow for the 4'–0" minimum dimension shown between the corridor wall and the end of casework.

MIL–HDBK–1191 Room Code, DNTG1 DWG NO. 1



Standard DTR Floor Plan

Scale: 1/2" = 1' – 0"

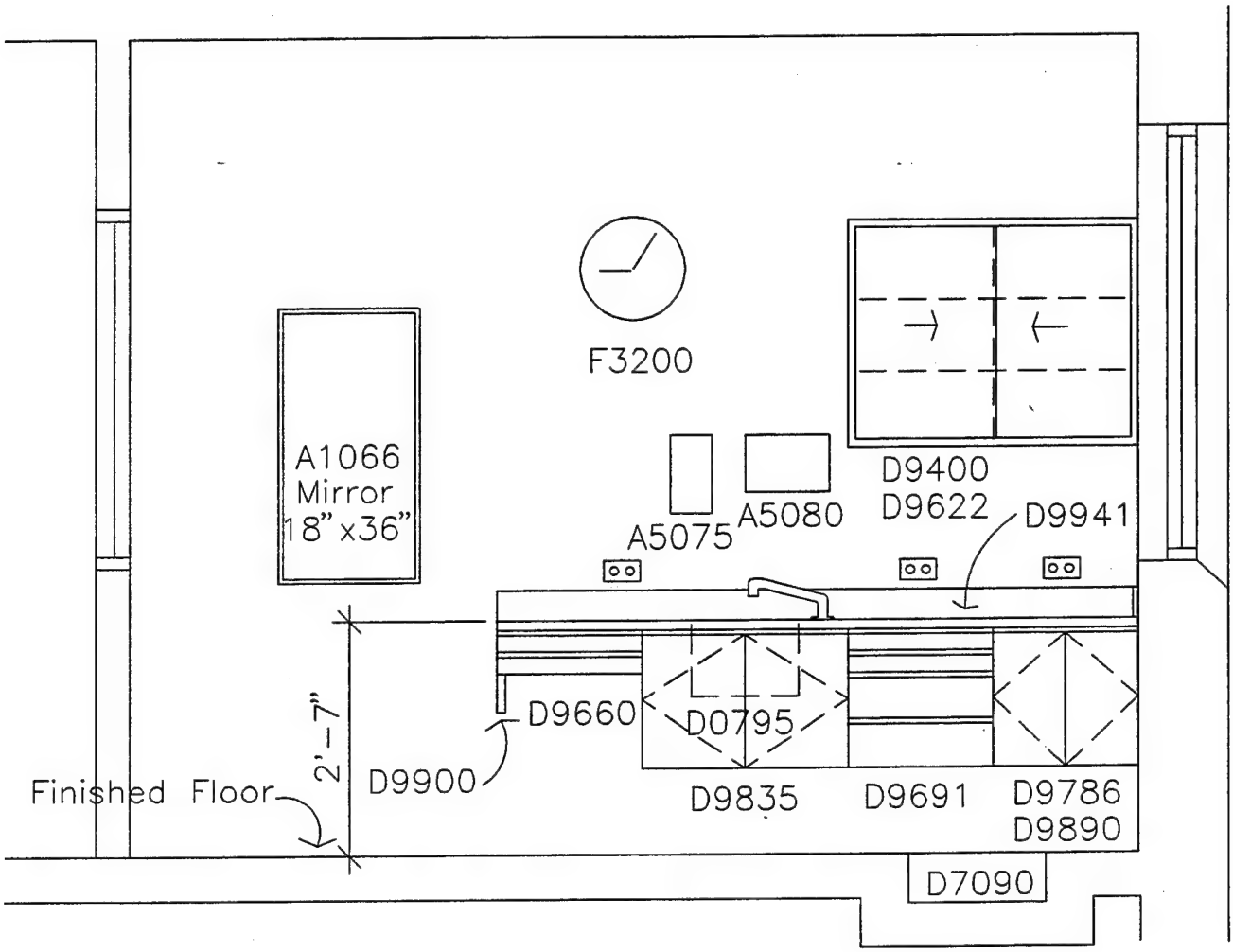
MIL–HDBK–1191 Room Code, DNTG1

DWG NO. 2

Standard (General)

Standard DTR Equipment List

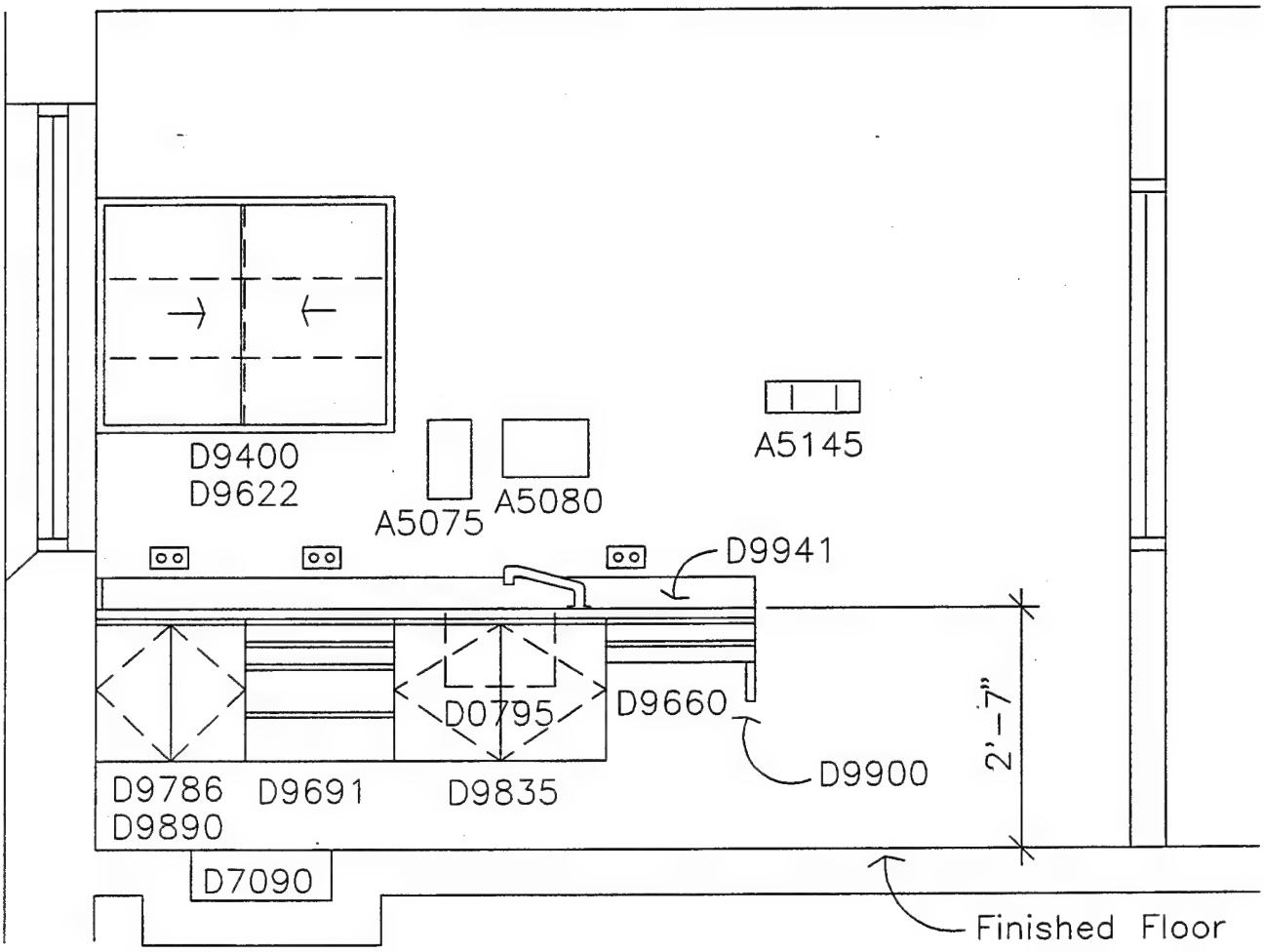
JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6050	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D8850	AMALGAMATOR, DENTAL
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9660	CABINET, BASE, W/H, 2DR, 6.5X19X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



Standard DTR Elevation – Left Side

Scale: 1/2" = 1' – 0"

DWG NO. 3

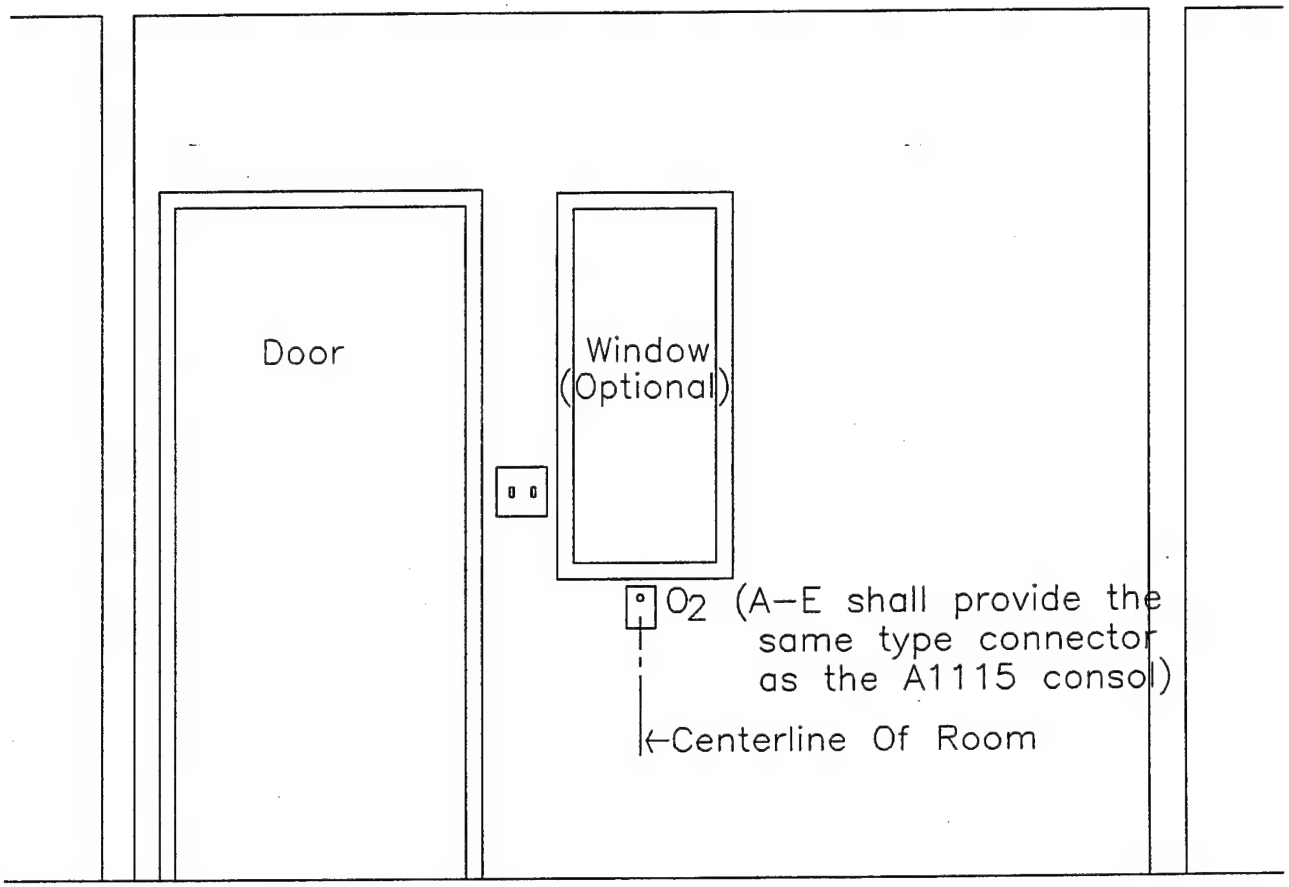


Standard DTR Elevation - Right Side

Scale: 1/2" = 1' - 0"

DWG NO. 4

Standard (General)

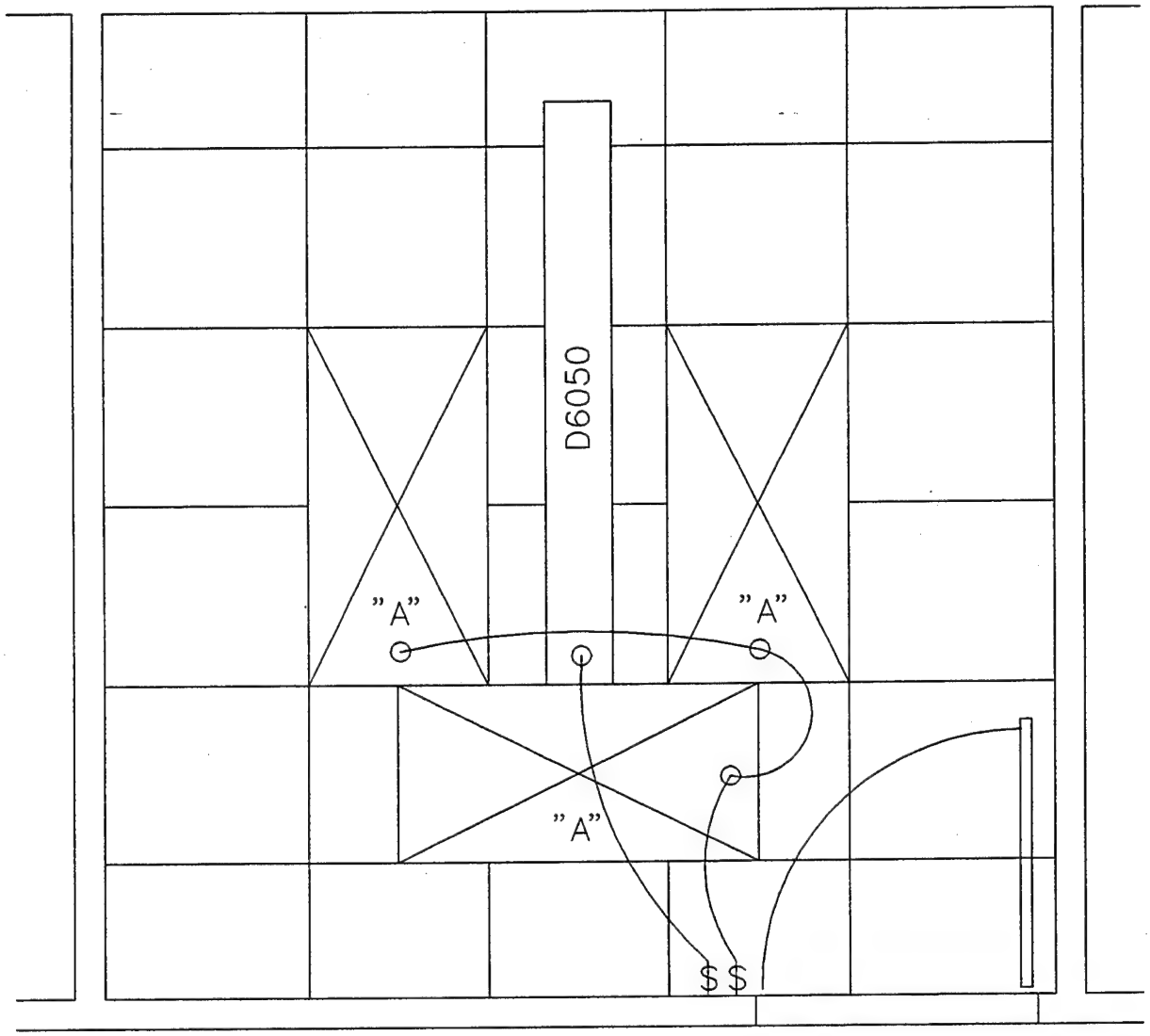


Standard DTR Elevation – Corridor Side

Scale: 1/2" = 1' – 0"

DWG NO. 5

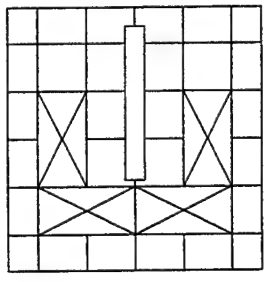
Standard (General)



Reflected Ceiling Plan

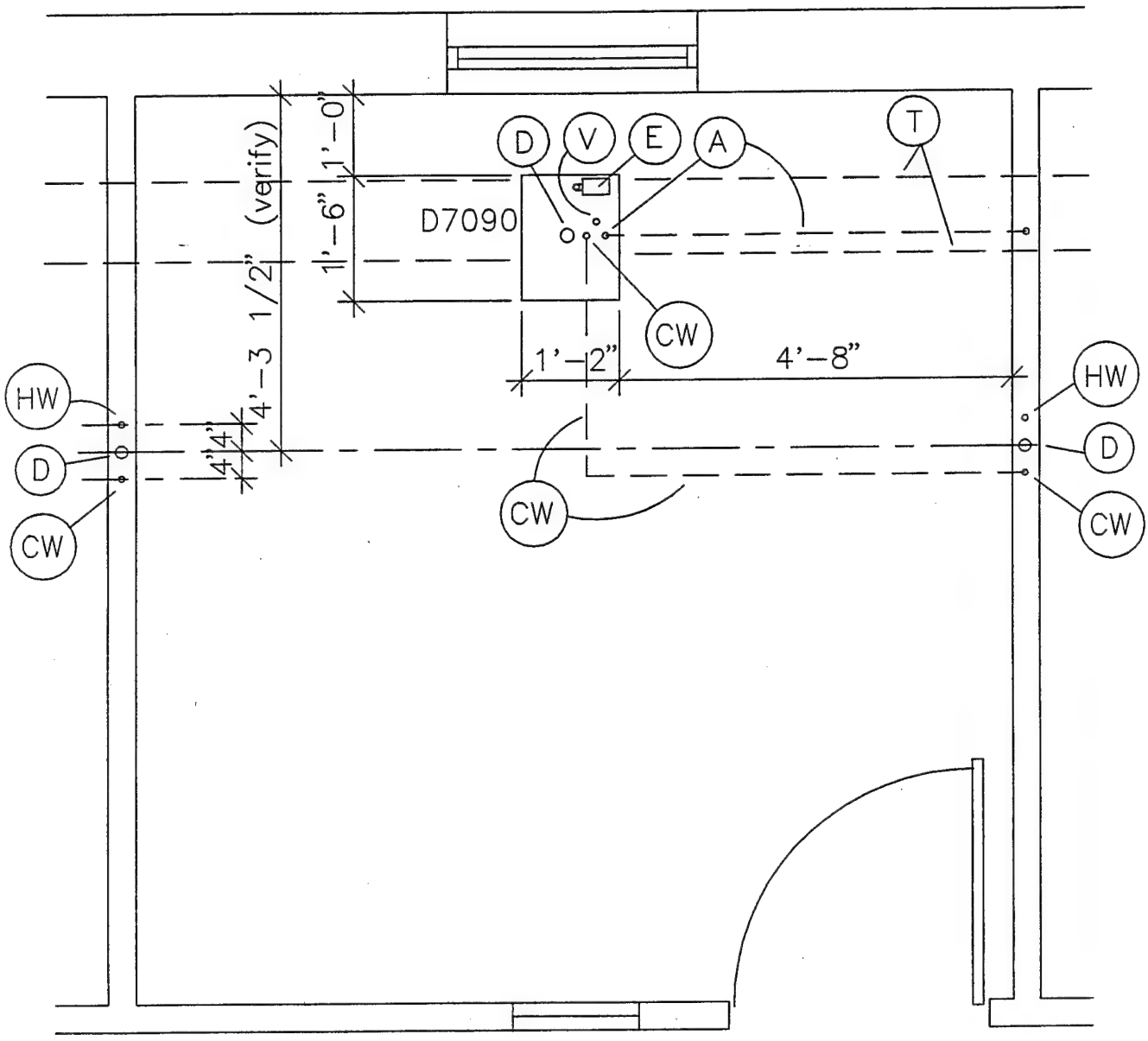
Scale: 1/2" = 1' - 0"

Note: "A" designates 24"x48" drop in fluorescent light fixture having tubes with color rendering index greater than 90 (CRI>90). Since there are a varity of tube types to select from and varying lighting design concepts, certain tubes may be selected with as little as 2000 lumen output; therefore, it may be necessary to provide as many as 4 light fixtures in a DTR to achieve the required foot candles. The ceiling schematic shown to the right reflects a recommended layout for a room requiring 4 light fixtures.



Ceiling Schematic

Standard (General) DWG NO. 6



Standard DTR Plumbing Plan

Scale: 1/2" = 1' - 0"

Legend

A – DCA, 90 PSI

D – 1 1/2" Drain

E – 115V 4-plex Elect Outlet

T – Utility trench

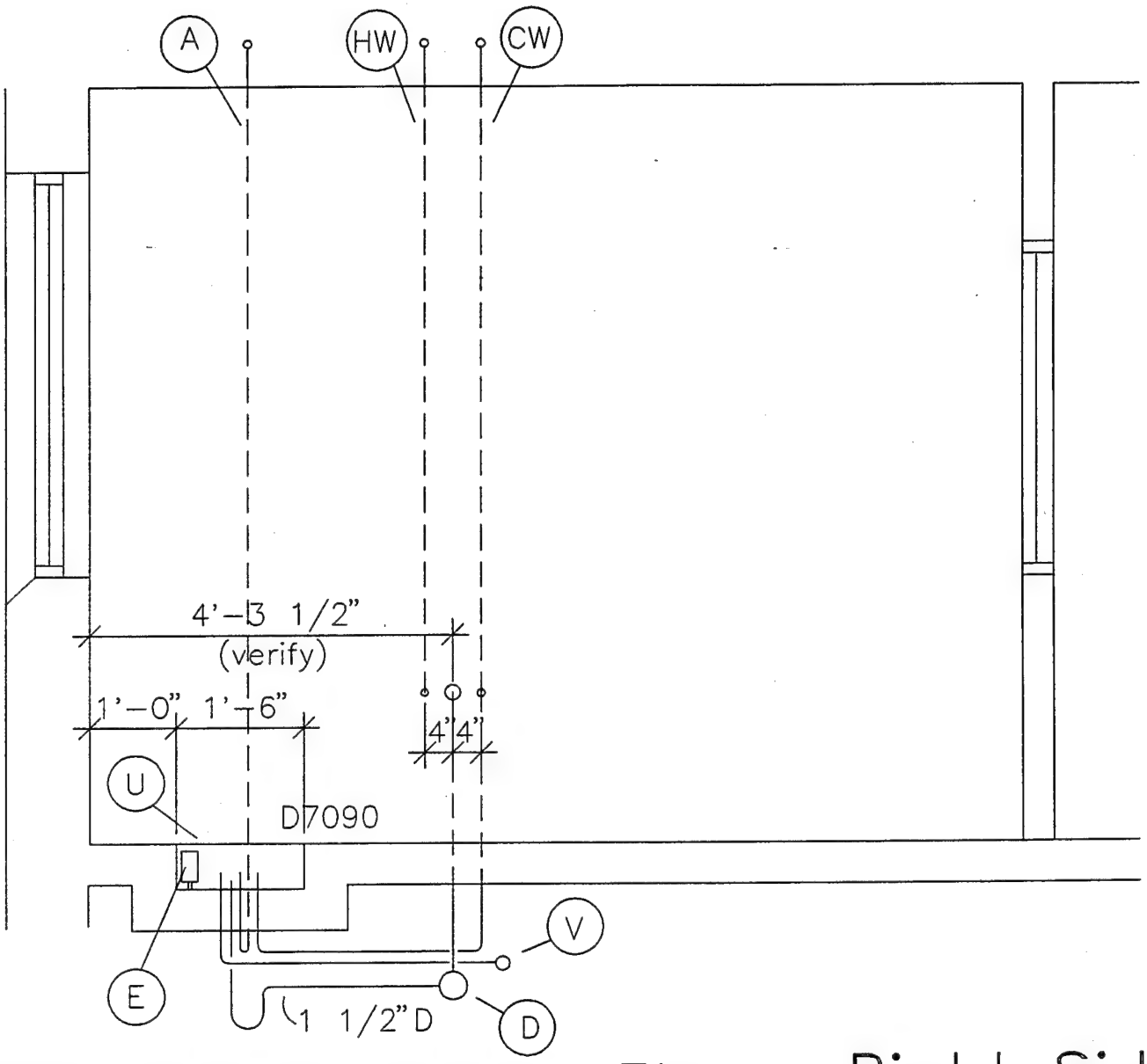
V – HVE

CW – 1/2" Cold Water

HW – 1/2" Hot Water

DWG NO. 7

Standard (General)



Std DTR Plumbing Elev - Right Side

Scale: 1/2" = 1' - 0"

Legend

A – DCA, 90 PSI

D – Drain, Main Line

E – 115V 4-plex Elect Outlet

U – Utility Service Center

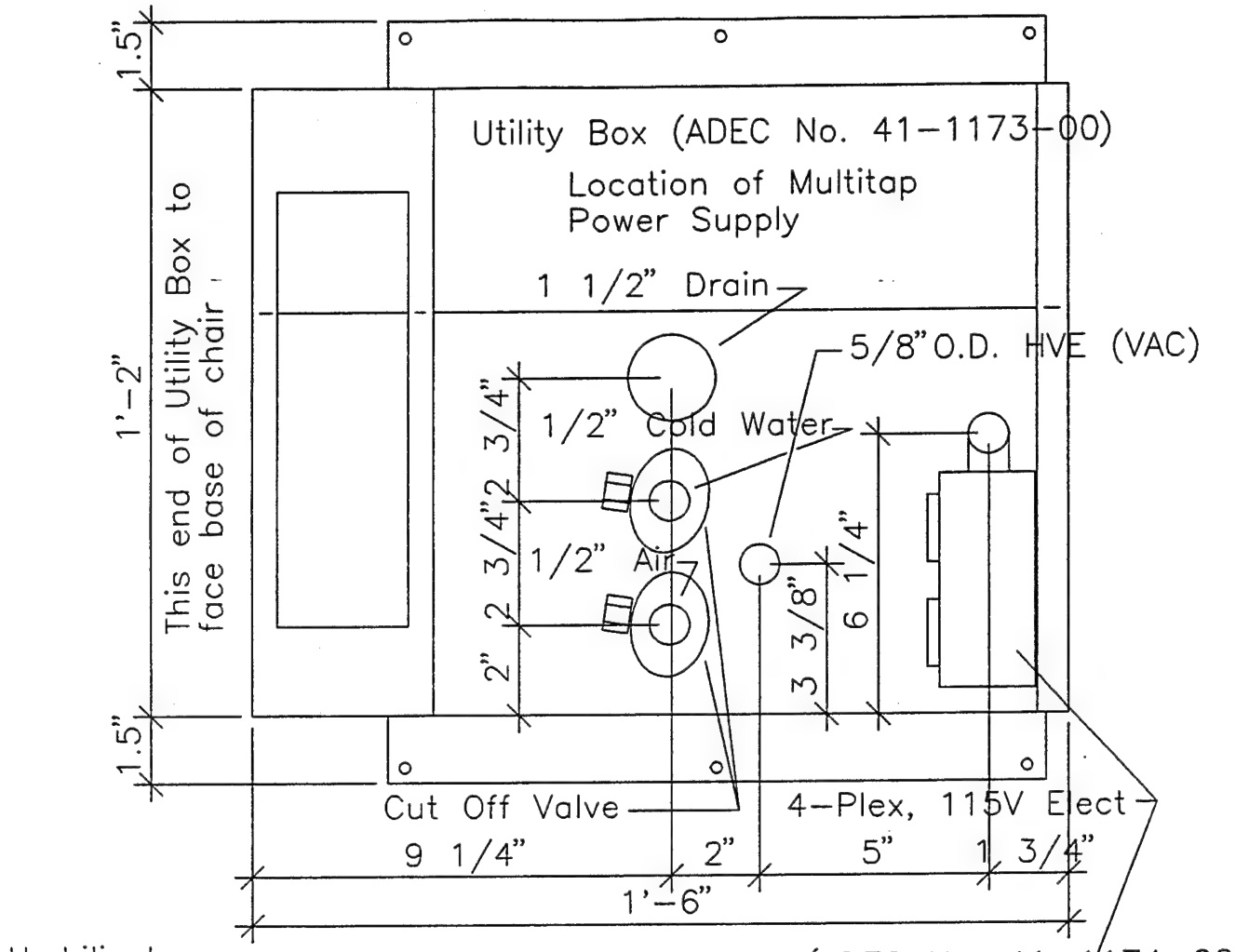
V – HVE, Main Line

CW – 1/2" Cold Water

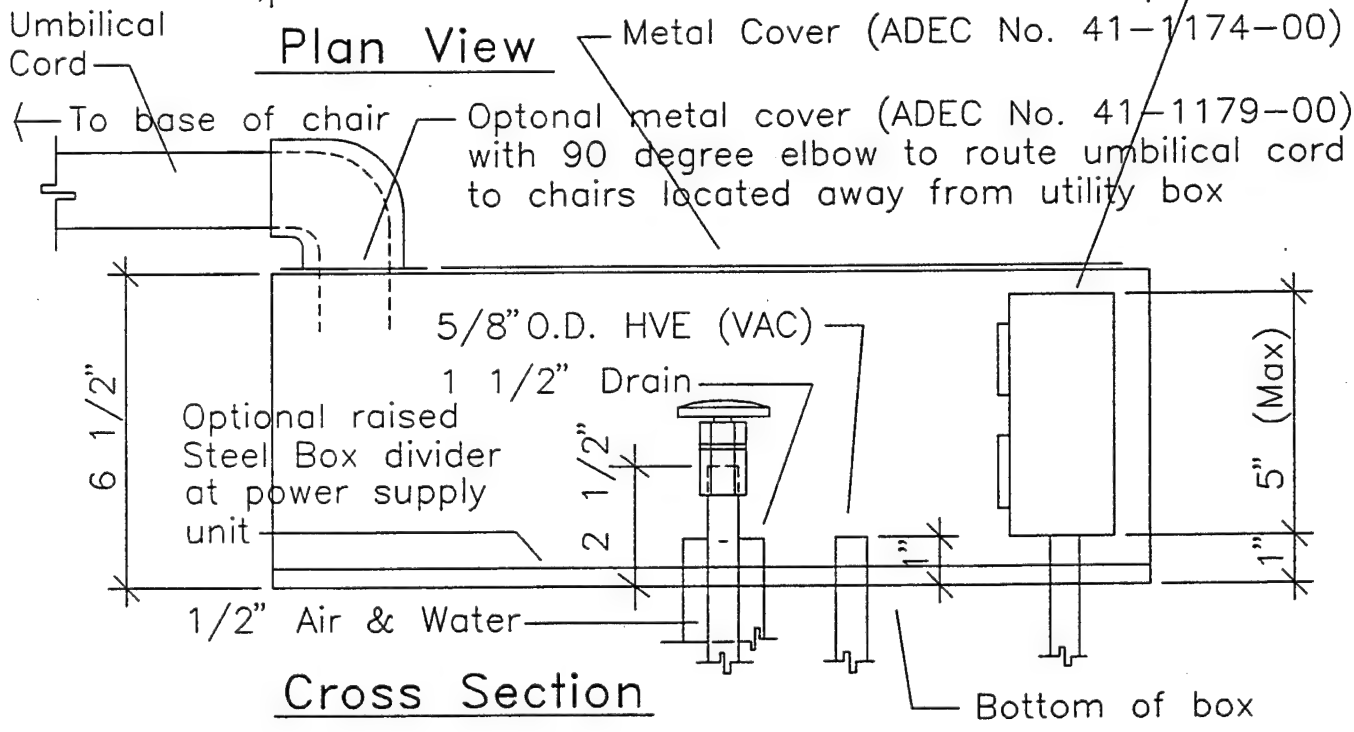
HW – 1/2" Hot Water

DWG NO. 8

Standard (General)



Plan View



Cross Section

Utility Service Center D7090

Scale: 3"=1'-0"

Standard (General) Utility Service Center

DWG NO. 9

D7090 UTILITY SERVICE CENTER

General Notes

1. This plan shows typical method of locating floor box utility center with relationship to dental chair.

2. Local regulations provide that licensed plumbers and electrician shall install utilities.

3. Make sure all plumbing conforms to prevailing local codes.

AIR, 1/2" pipe N.P.T. protruding 2" from bottom of box. Supplied by contractor. Manual shut-off valve supplied by dental dealer to be installed by contractor. Air pressure 80-100 P.S.I. Air plumbing should be flushed clean before making final connections to dental equipment.

WATER, 1/2" pipe N.P.T. protruding 2" from bottom of box. Supplied by contractor. Manual shut-off valve supplied by dental dealer to be installed by contractor. Air pressure 40-80 P.S.I. Water plumbing should be flushed clean before making final connections to dental equipment.

ELECTRICAL, 1/2' conduit and box with quad or equal receptacle supplied by contractor. Wire box as per code with top of the box no higher than 5" above floor of box. Voltage: 110 volts 3 wire.

CENTRAL VACUUM, plumbing up to utility floor box utility center should be specified by central vacuum supplier and terminated in utility center with 5/8" O.D. tube.

GRAVITY DRAIN, 1-1/2" nominal pipe protruding 1" from bottom of box. NOTE: Place trap in line to conform with local codes. Supplied by contractor.

NOTE: This template to be used for plumbing and electrical locations only. Floor box mounting hole locations should be taken from the floor box base being installed.

Standard (General)
Utility Service Center

UTILITY CENTERS AND UTILITY SUPPLIES

1. Utility centers (enclosures) are included parts of the dental unit package and are delivered with these items of equipment. The utility centers are installed by those responsible for, and at the time of, unit installations.

2. Utility supplies to the utility center locations and the terminal fittings for utility stub-ups are part of the facility plumbing system, and shall be installed and tested before wall closure. These utility supplies and terminal fittings shall be the responsibility of the O&M or MILCON contractor.

3. All utility centers (utility junction boxes) shall be manufacturer's standard surface-mounted product. Maximum specification dimensions shall not exceed 18" wide, 14" deep, and 6.5" high. See DWG NO. 9. Minimum utility center dimensions shall be sufficient to cover (with space for edge fastening) a floor opening.

3.1 Utilities for floor-mounted centers supporting the dental operating unit shall include:

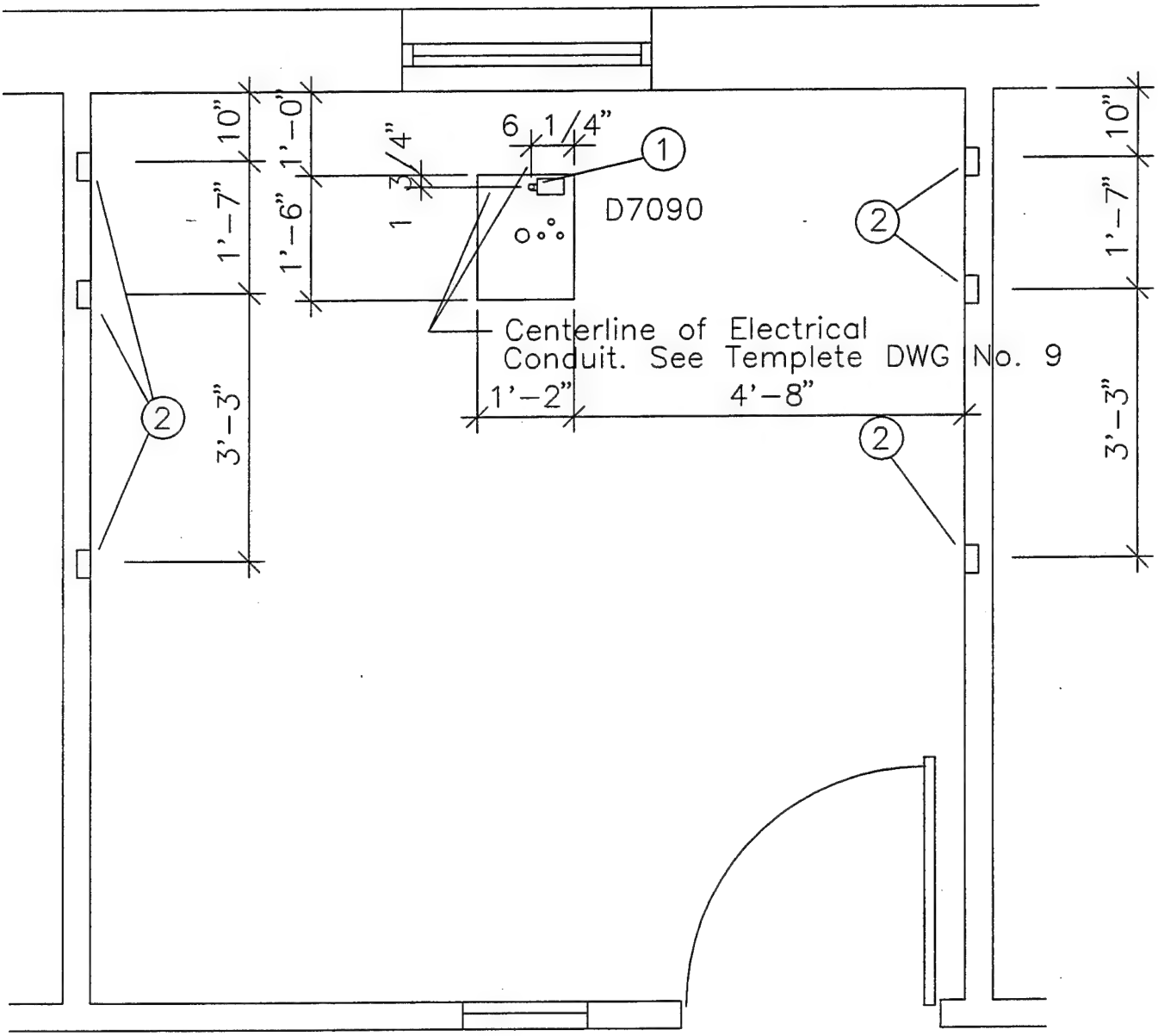
Utility	Terminal Fitting
90 PSIG DCA	Manual valve with 3/8 (.375) inch compression-stop outlet (see Dental Compressed Air Guide specifications)
Water	Manual valve with 3/8 (.375) inch compression-stop outlet (see Special Note 1)
Electrical	110 VAC, 15A circuit, and small junction box
HVE (Vac)	5/8" (.625) inch O.D. (nominal) pipe trapped
Drain	1-1/2 (1.5) inch I.D. (nominal) pipe trapped

Special Note 1: When a facility is plumbed for treated (softened) water, two (2) manual valves, each with 3/8-inch compression stop, shall be provided and labeled; one for treated water and one for service water. Treated water shall be routed to the unit water heater. Service water shall be routed to the unit cuspidor and cup filler.

4. For reasons of cost control on O&M and MILCON projects, and compatibility of equipment obtained though central procurement methods, utilities suppling dental equipment utility centers shall not be layed out according to any commercial proprietary template. Instead, the contractor shall use the template furnished by the actual selected equipment supplier.

4.1 Layout of utility supply terminal fittings at the utility center opening shall be such that terminal fittings or electrical junction box tops shall not protrude beyond 1/2" from the inner surface of the utility center box top. Conversely, no terminal fitting bottom or drain top, or electrical junction box bottom shall be located less than 1 inch distance from the bottom of the utility center junction box. See DWG NO. 9.

4.2 When viewed through the floor opening, vacuum and drain inlets and all other fittings shall be located as shown on DWG NO. 9. All fitting locations shall permit unimpeded access to valve handles and for connection of utility center tubing to terminal fitting outlets through the utility center opening.



Standard DTR Electrical Plan

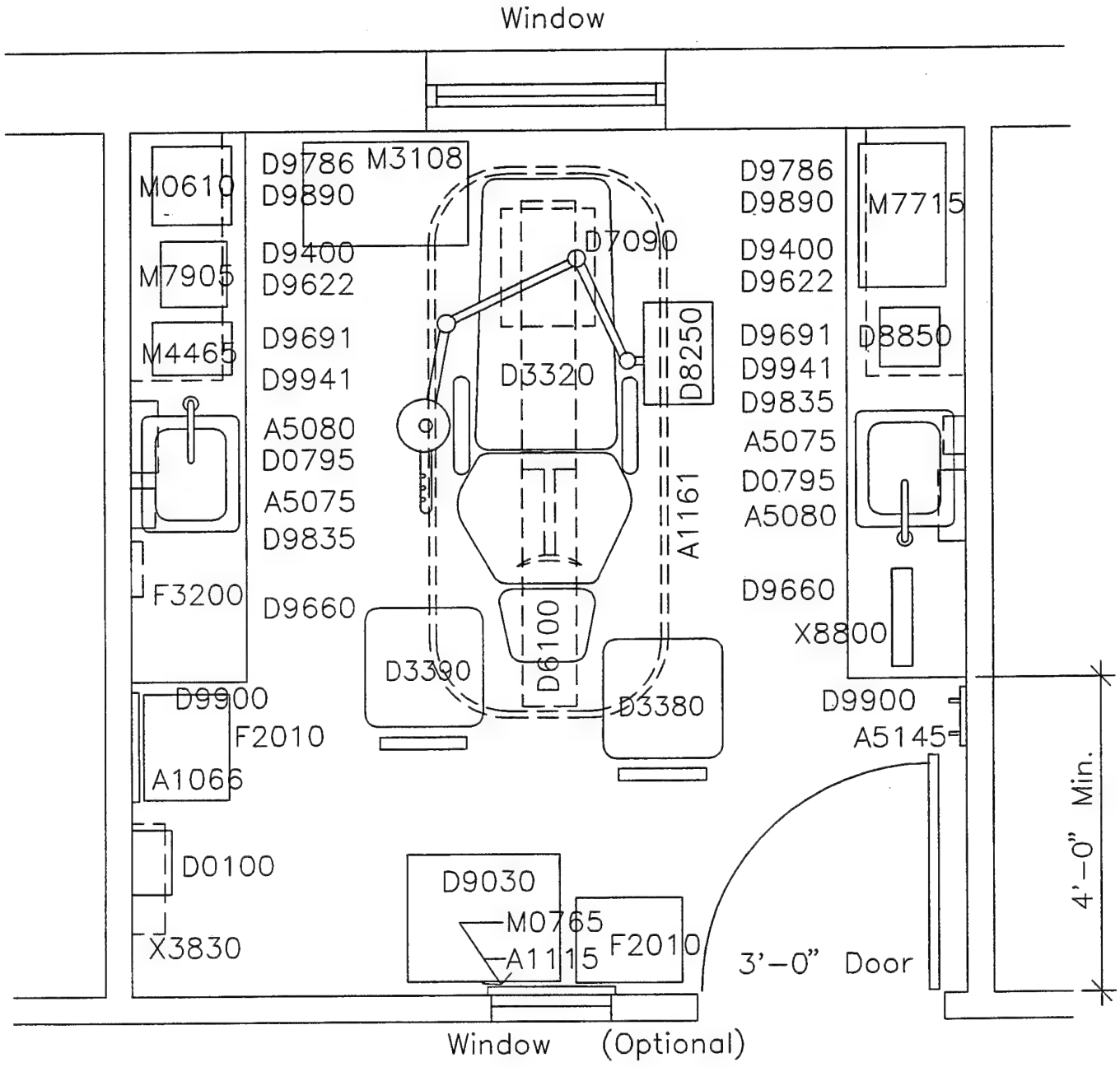
Scale: 1/2" = 1' - 0"

Notes:

(1) 115V, 20 Amp, Floor Electrical 4-Plex Convenience Outlet. See STD DTR P-E-1, DWG NO. 9

(2) 115V Electrical Duplex Convenience outlet, Located at 38" A.F.F., GFI Protected.

DWG NO. 10



Oral Surgery Floor Plan

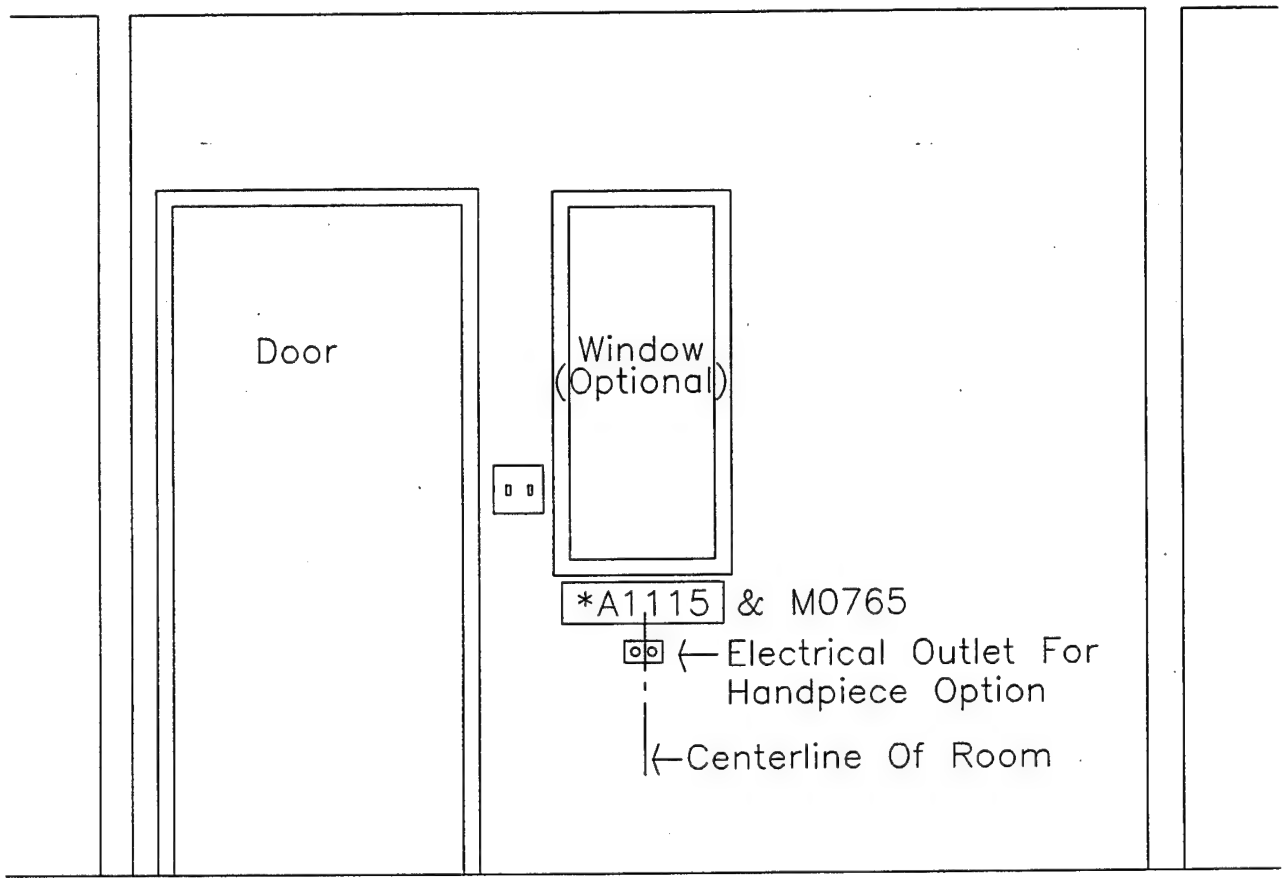
Scale: 1/2" = 1' – 0"

Note: Room size minimum dimensions and other room planning requirements shall be similar to the standard DTR drawings. See STD DTR DWG NOs. 1, 3, 4, 7, 8, 9, and 10. For Corridor Side Elevation and Reflected Ceiling Plan, see ORAL SURG DWG NO. 12 and 13.

MIL–HDBK–1191 Room Code, DNTS1 DWG NO. 11

Oral Surgery Equipment List

JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A1115	CONSOLE, SERVICE, INFANT, PREFAB
A1161	TRACK, IV, OVAL, CEIL/MNTD, 3FTX7FT
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0100	ANALGESIA UNIT,INHALATION, USES C/UTILS
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6100	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D8850	AMALGAMATOR, DENTAL
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9660	CABINET, BASE, W/H, 2DR, 6.5X19X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
M0610	ANALYZER, OXYGEN, 0-100%
M0765	REGULATOR, VACUUM, C/SYSTEM
M3108	ELECTROSURGICAL UNIT, MBL, UNBLENDED
M4465	BP CUFF, ELECTRIC
M7715	ELECTROCARDIOGRAPH, PORT, DIRECT WRITING
M7905	OXIMETER
X3830	ILLUMINATOR, FILM, SNGL, W/MNTD, 20X17X5
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



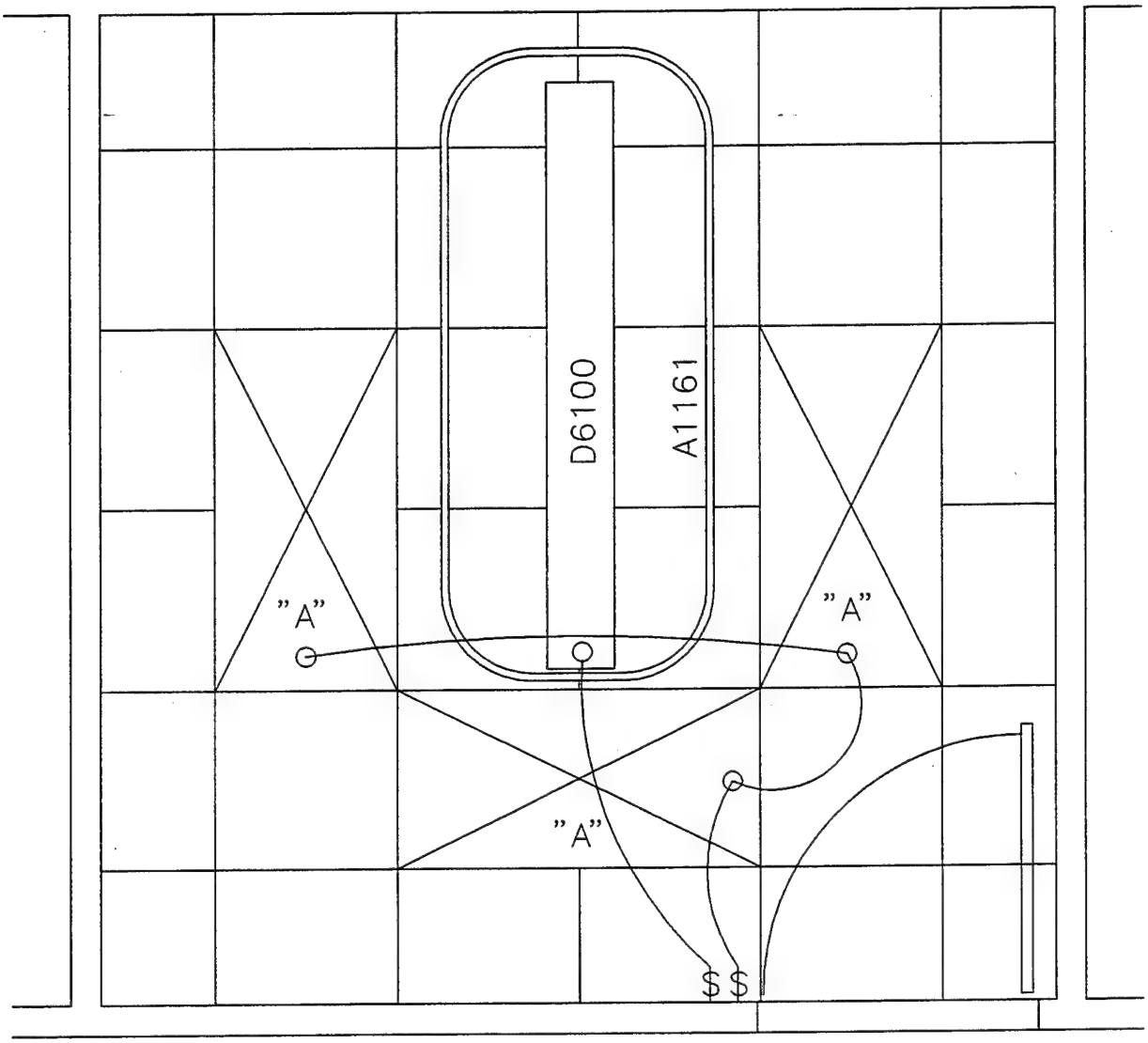
Oral Surgery Elevation – Corridor Side

Scale: 1/2" = 1' – 0"

* | O_2 | N_2O | MV | N_2 or SHDA | WAG |

A1115 Medical gas console to include Oxygen (O_2), Nitrous Oxide (N_2O), Medical vacuum (MV), Nitrogen (N_2) or Surgical handpiece drive air (SHDA), and Waste anesthesia gas (WAG)

DWG NO. 12

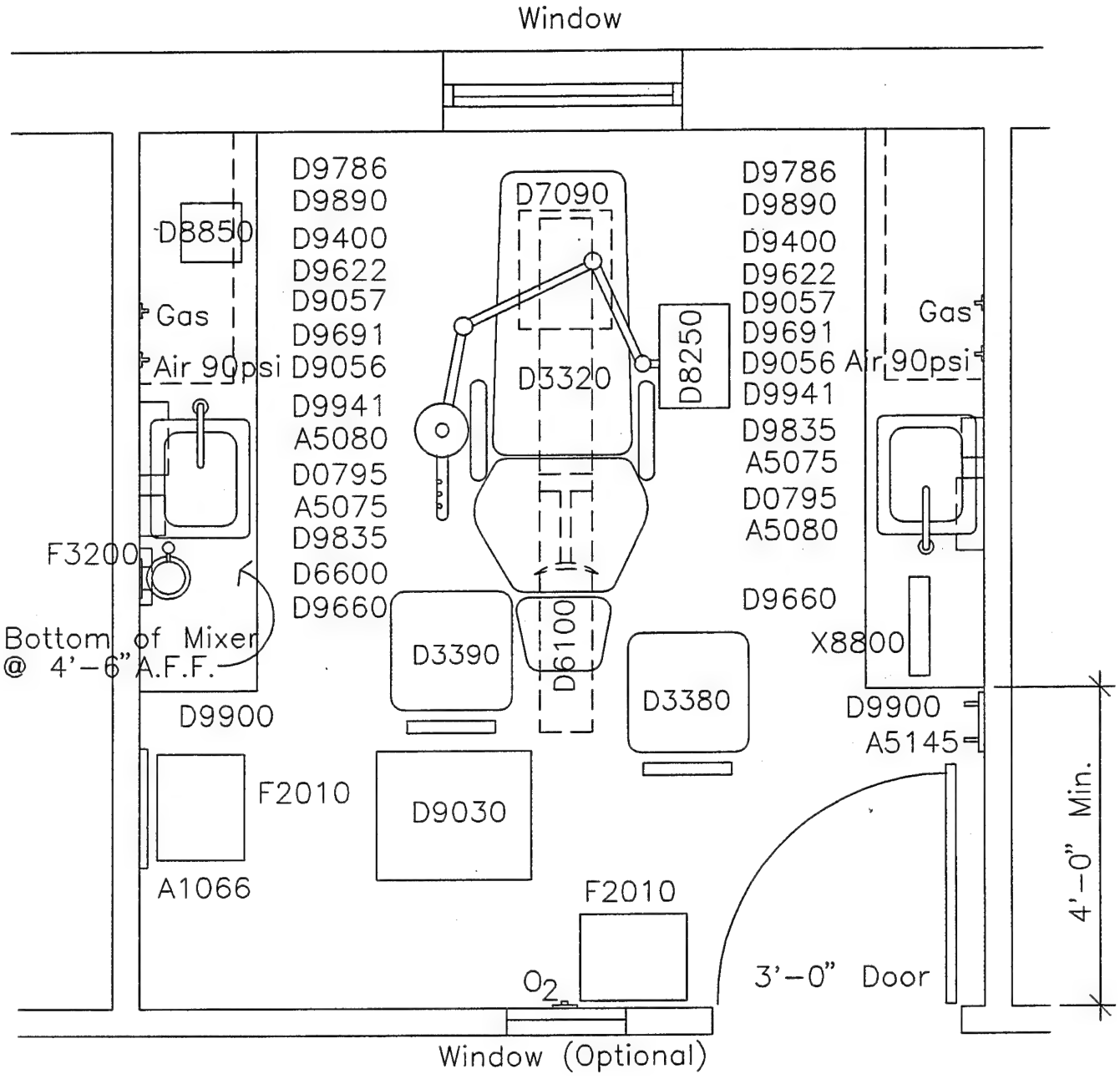


Reflected Ceiling Plan

Scale: 1/2" = 1' - 0"

Note: Note and ceiling schematic shown at bottom of DWG NO. 6 on page 11 shall apply to this drawing.

DWG NO. 13



Prosthodontic DTR Floor Plan

Scale: 1/2" = 1' - 0"

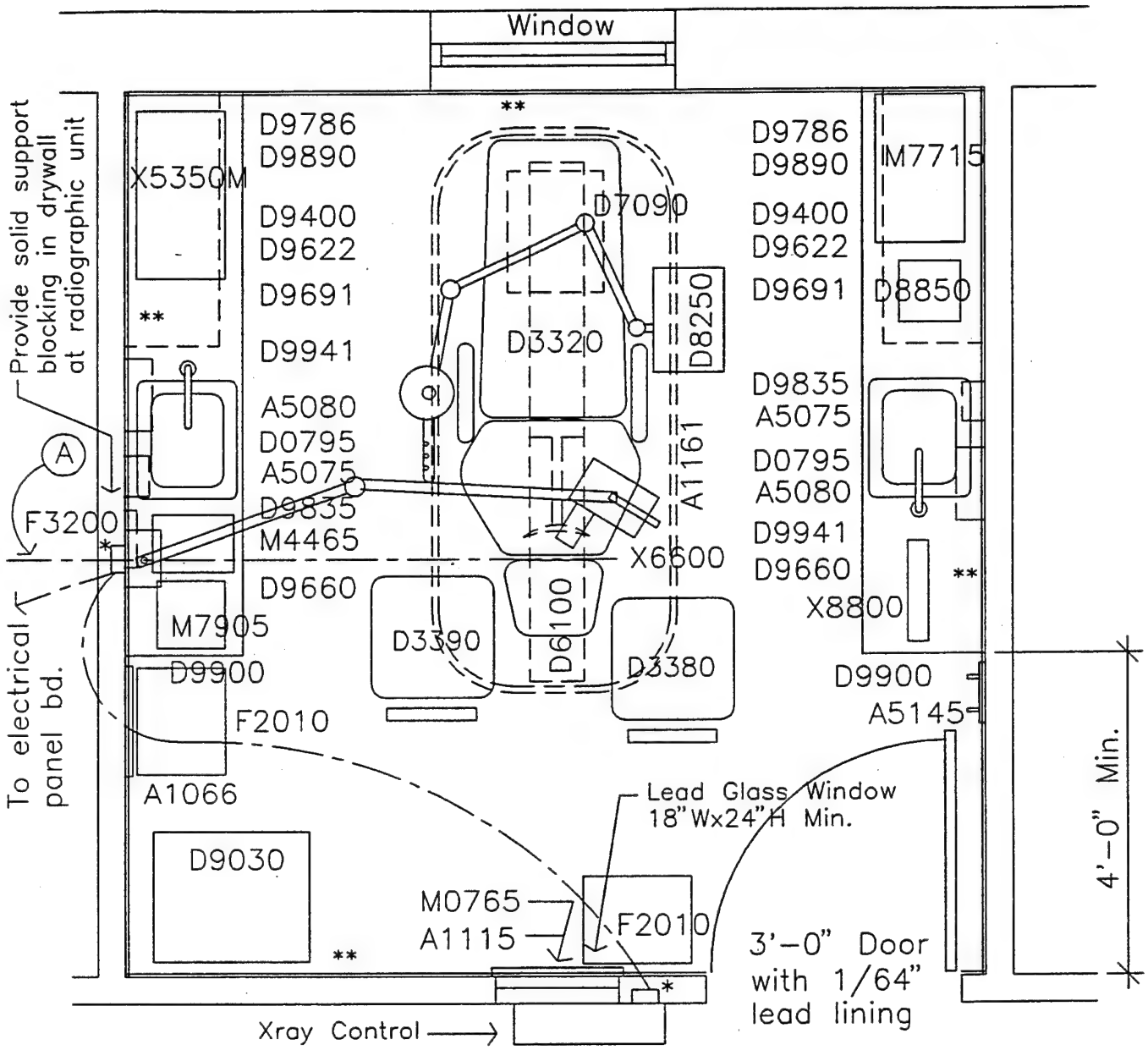
Note: Room size minimum dimensions and other room planning requirements shall be similar to standard DTR drawings. See STD DTR DWG NOs. 1, 3, 4, 5, 6, 7, 8, 9, and 10.

MIL-HDBK-1191 Room Code, DNTP1 DWG NO. 14

Prosthodontic

Prosthodontic DTR Equipment List

JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6100	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D6600	MIXER/INVESTOR, VACUUM, 2SP, 1/3HP
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D8850	AMALGAMATOR, DENTAL
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9056	VALVE, AIR, NEEDLE CONTROL
D9057	VALVE, GAS, NEEDLE CONTROL
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9660	CABINET, BASE, W/H, 2DR, 6.5X19X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



Endodontic DTR Floor Plan

Scale: 1/2" = 1' - 0"

Note: Room size minimum dimensions and other room planning requirements shall be similar to Standard DTR drawings. See standard DTR drawing NOs. 1, 3, 4, 7, 8, 9, and 10. For Corridor Side Elevation and Reflected Ceiling Plan, see Oral Surgery Drawing NO. 12 and 13.

Ⓐ – The A–E shall locate the centerline of the X6600 Xray's arm (when fully extended and perpendicular to the wall) to be lined up with the base of the D3320 patient chair's head rest. Mount with arm centerline at 42" A.F.F.

*See note on Drawing NO. 30 refering to equipment power supply wiring, conduit, and J–boxes.

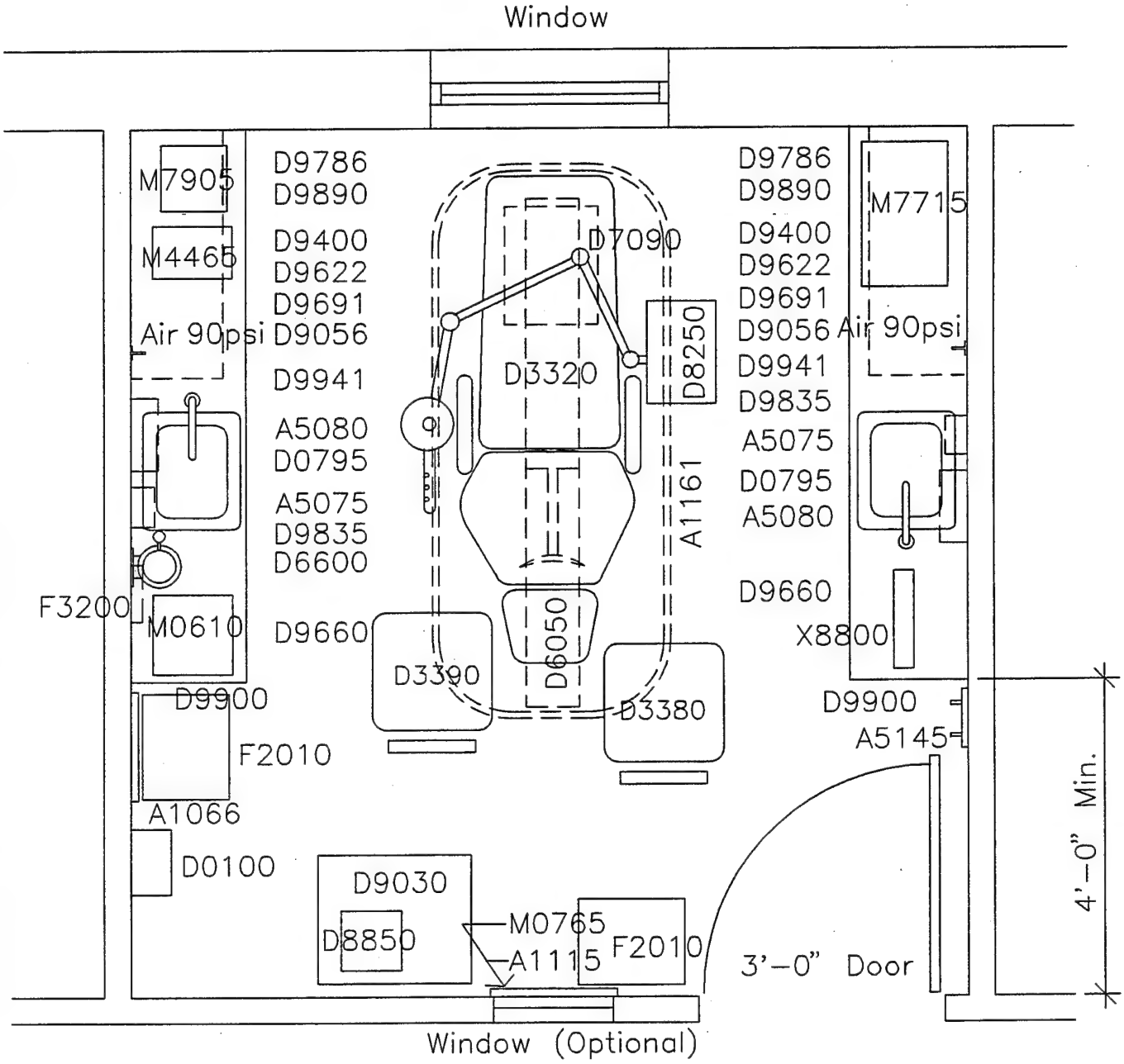
**Xray lead shielding may be required. A–E and User shall provide required data on the Endodontics Room(s) for analysis to AL/OEBZ, 2402 East Drive, Brooks AFB, TX 78235–5114.

MIL–HDBK–1191 Room Code, DNTE1

DWG NO. 15

Endodontic DTR Equipment List

JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A1115	CONSOLE, SERVICE, INFANT, PREFAB
A1161	TRACK, IV, OVAL, CEIL/MNTD, 3FTX7FT
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6100	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D8850	AMALGAMATOR, DENTAL
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9660	CABINET, BASE, W/H, 2DR, 6.5X19X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
M0765	REGULATOR, VACUUM, C/SYSTEM
M4465	BP CUFF, ELECTRIC
M7715	ELECTROCARDIOGRAPH, PORT, DIRECT WRITING
M7905	OXIMETER
X5350	PROCESSOR, FILM, DENTAL, AUTO, TBL/MNTD
X6600	RADIOGRAPHIC UNIT, DENTAL, W/MNTD, 7MA
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



Specialist DTR Floor Plan

Scale: 1/2" = 1' - 0"

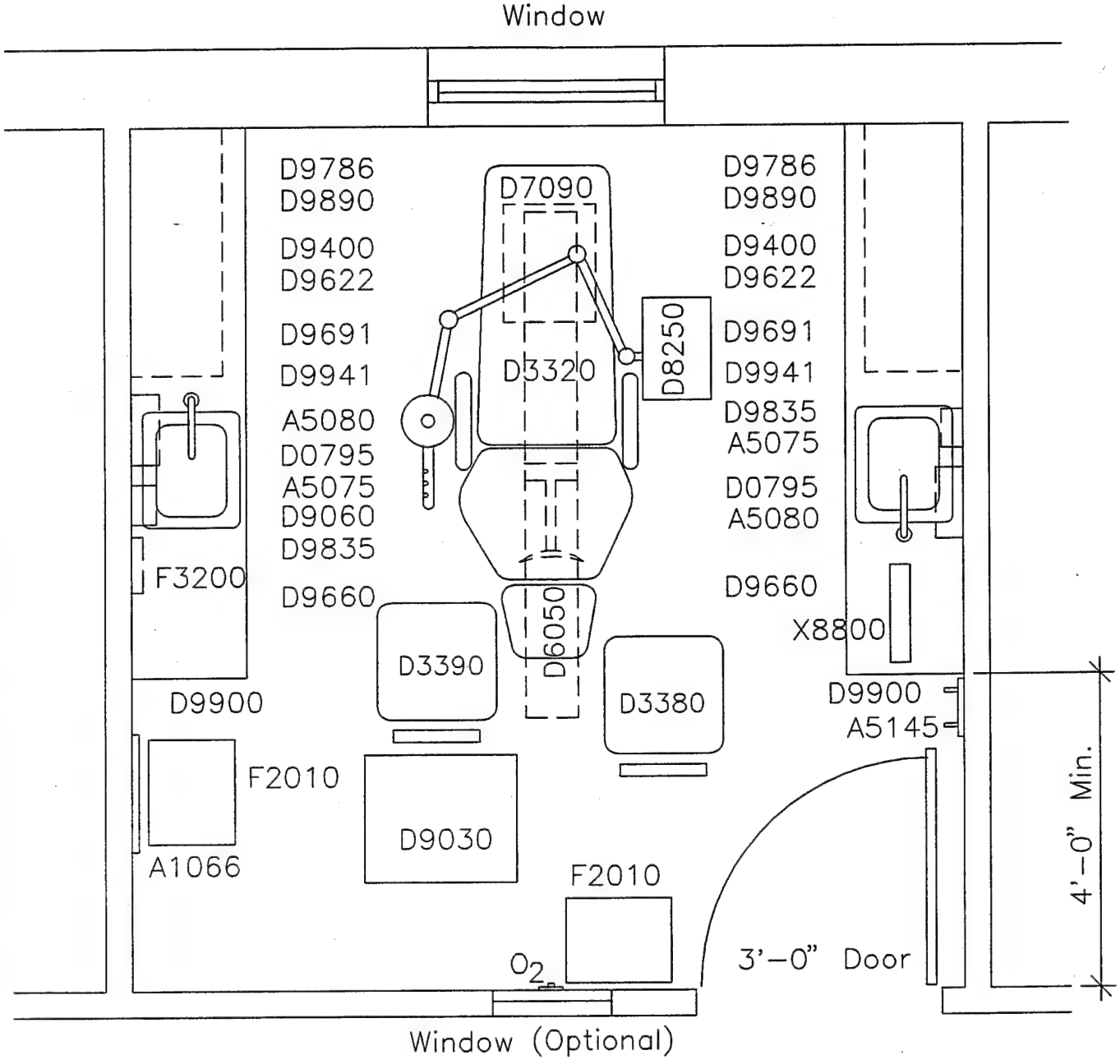
Note: Room size minimum dimensions and other room planning requirements shall be similar to the standard DTR drawings. See STD DTR DWG NOs. 1, 3, 4, 7, 8, 9, and 10. For Corridor Side Elevation and Reflected Ceiling Plan, see ORAL SURG DWG NO. 12 and 13.

MIL-HDBK-1191 Room Code, DNTC1 DWG NO. 16

Specialist (Comprehensive)

Specialist DTR Equipment List

JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A1115	CONSOLE, SERVICE, INFANT, PREFAB
A1161	TRACK, IV, OVAL, CEIL/MNTD, 3FTX7FT
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0100	ANALGESIA UNIT,INHALATION, USES C/UTILS
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6050	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D6600	MIXER/INVESTOR, VACUUM, 2SP, 1/3HP
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D8850	AMALGAMATOR, DENTAL
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9056	VALVE, AIR, NEEDLE CONTROL
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9660	CABINET, BASE, W/H, 2DR, 6.5X19X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
M0610	ANALYZER, OXYGEN, 0-100%
M0765	REGULATOR, VACUUM, C/SYSTEM
M4465	BP CUFF, ELECTRIC
M7715	ELECTROCARDIOGRAPH, PORT, DIRECT WRITING
M7905	OXIMETER
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



Preventative Dent DTR Floor Plan

Scale: 1/2" = 1' – 0"

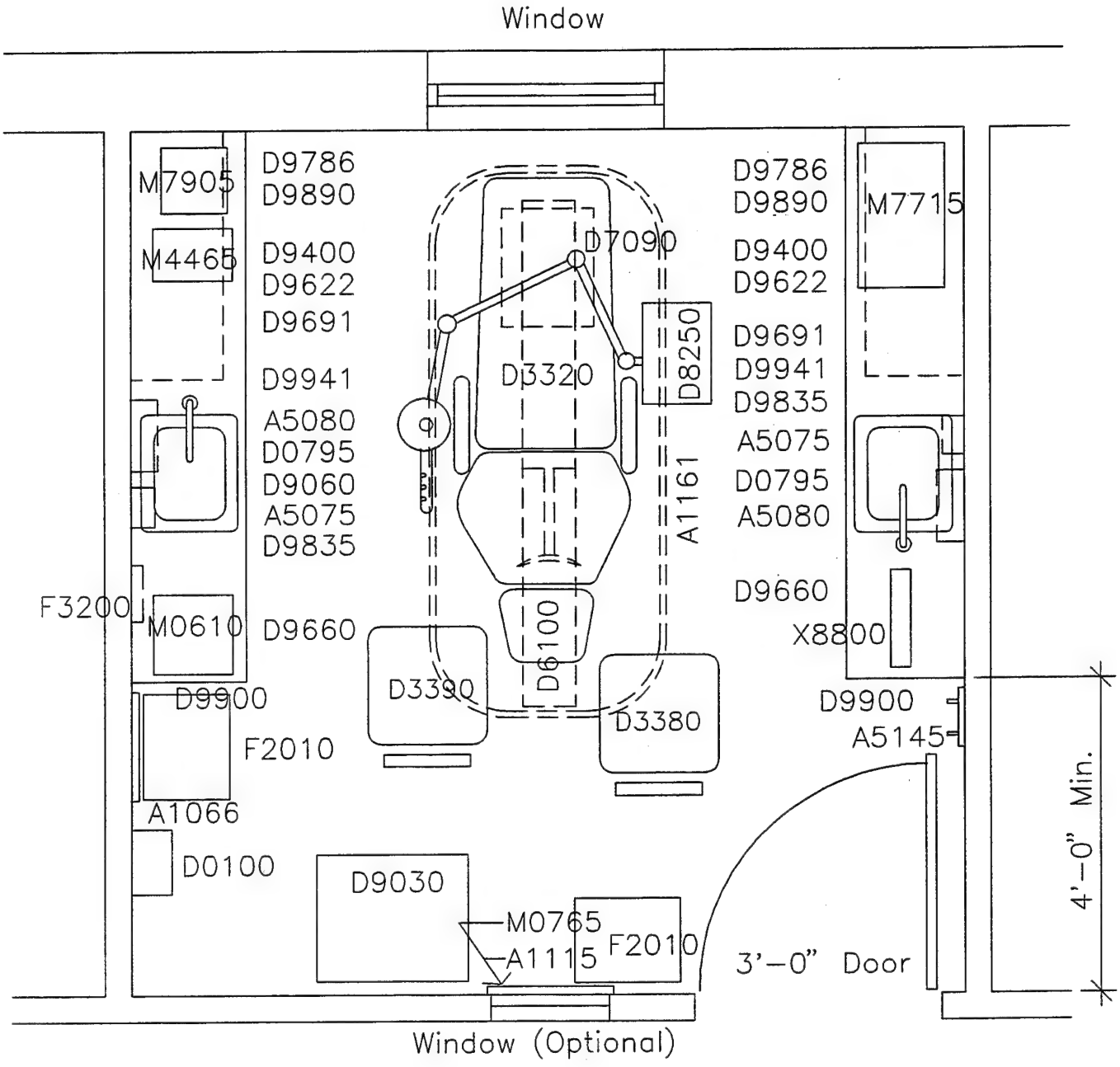
Note: Room size minimum dimensions and other room planning requirements shall be similar to standard DTR drawings. See STD DTR DWG NOs. 1, 3 ,4, 5, 6, 7, 8, 9, and 10.

MIL–HDBK–1191 Room Code, DNTG2 DWG NO. 17

Preventative (Oral Hygiene)

Preventative DTR Equipment List

JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6050	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9660	CABINET, BASE, W/H, 2DR, 6.5X19X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



Periodontic DTR Floor Plan

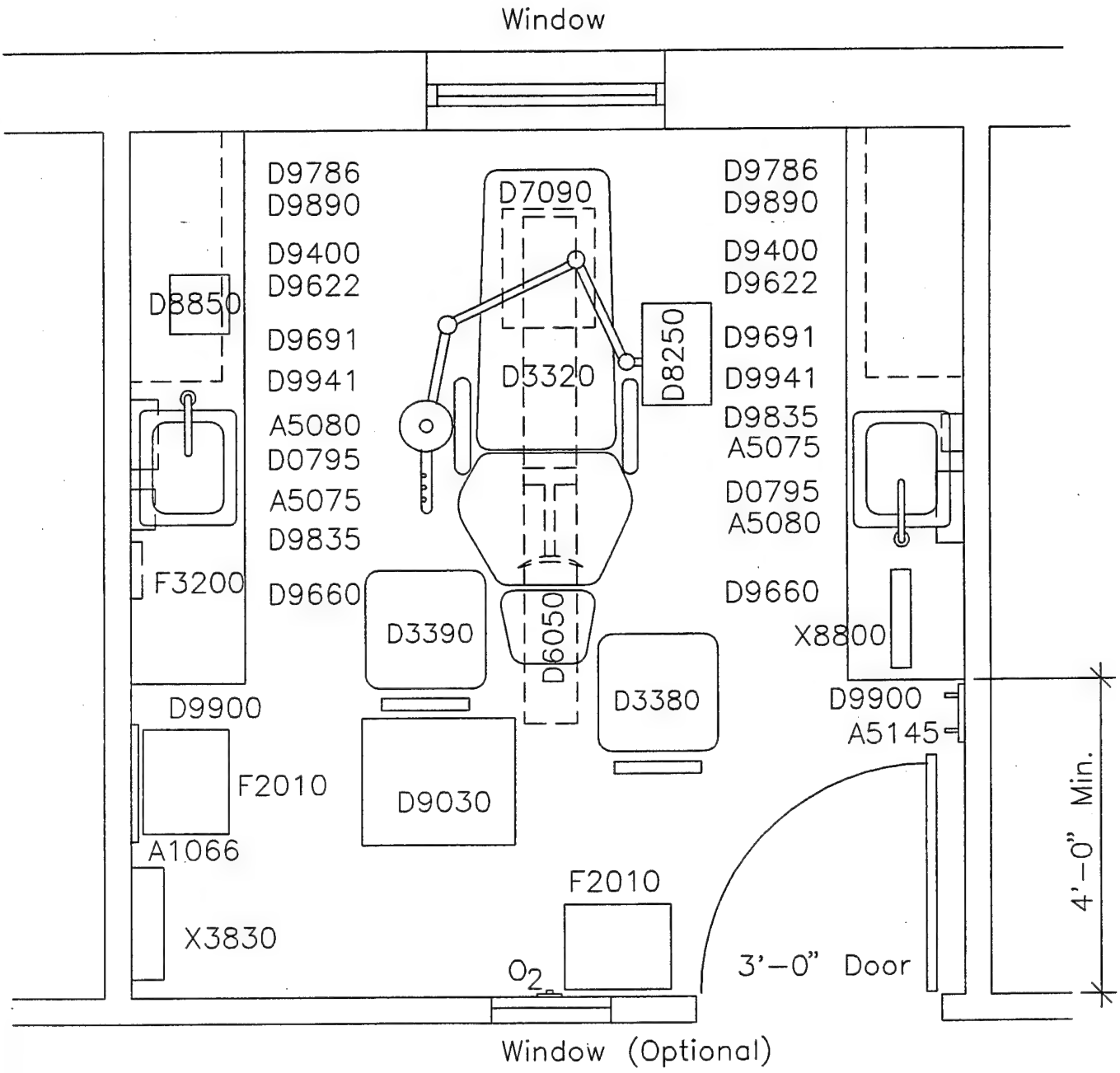
Scale: 1/2" = 1' - 0"

Note: Room size minimum dimensions and other room planning requirements shall be similar to the standard DTR drawings. See STD DTR DWG NOs. 1, 3, 4, 7, 8, 9, and 10. For Corridor Side Elevation and Reflected Ceiling Plan, see ORAL SURG DWG NO. 12 and 13.

MIL-HDBK-1191 Room Code, DNTP2 DWG NO. 18

Periodontic DTR Equipment List

JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A1115	CONSOLE, SERVICE, INFANT, PREFAB
A1161	TRACK, IV, OVAL, CEIL/MNTD, 3FTX7FT
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0100	ANALGESIA UNIT,INHALATION, USES C/UTILS
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6100	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9660	CABINET, BASE, W/H, 2DR, 6.5X19X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
M0610	ANALYZER, OXYGEN, 0-100%
M0765	REGULATOR, VACUUM, C/SYSTEM
M4465	BP CUFF, ELECTRIC
M7715	ELECTROCARDIOGRAPH, PORT, DIRECT WRITING
M7905	OXIMETER
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



Orthodontic DTR Floor Plan

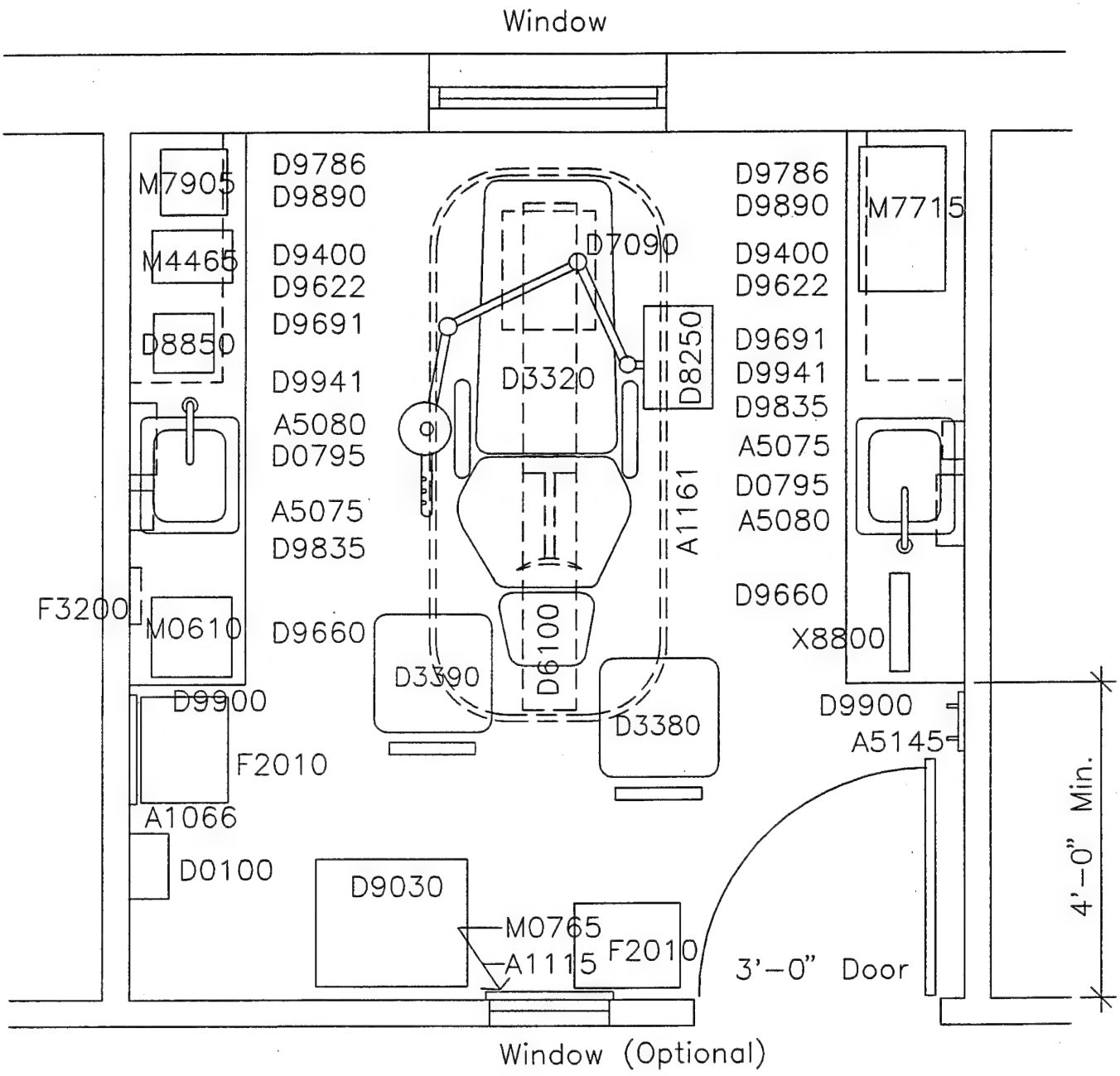
Scale: 1/2" = 1' – 0"

Note: Room size minimum dimensions and other room planning requirements shall be similar to standard DTR drawings. See STD DTR DWG NOs. 1, 3, 4, 5, 6, 7, 8, 9, and 10

MIL–HDBK–1191 Room Code DNTB1 DWG NO. 19

Orthodontic DTR Equipment List

JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6050	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D8850	AMALGAMATOR, DENTAL
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9660	CABINET, BASE, W/H, 2DR, 6.5X19X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
X3830	ILLUMINATOR, FILM, SNGL, W/MNTD, 20X17X5
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



Pedodontic DTR Floor Plan

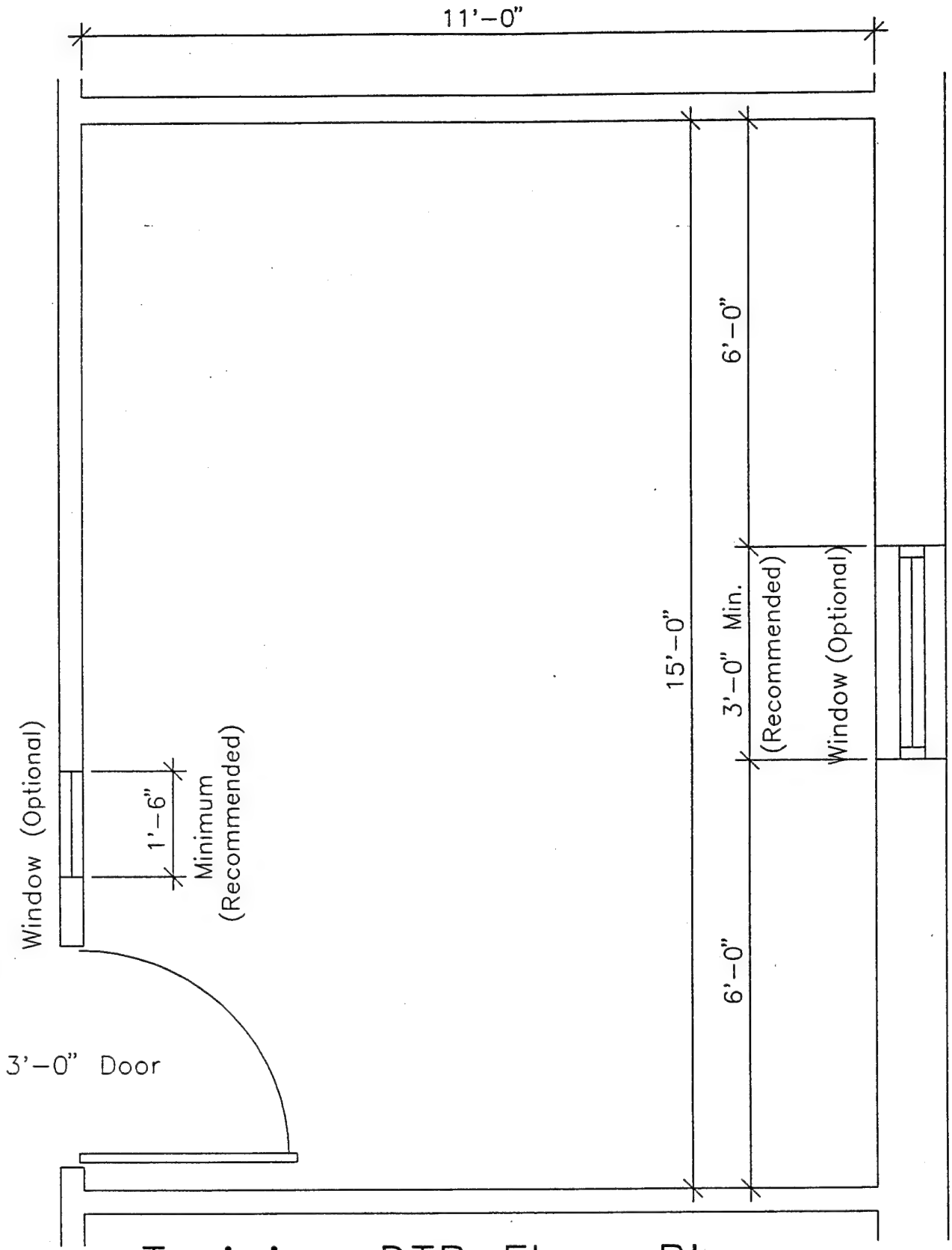
Scale: 1/2" = 1' – 0"

Note: Room size minimum dimensions and other room planning requirements shall be similar to the standard DTR drawings. See STD DTR DWG NOs. 1, 3, 4, 7, 8, 9, and 10. For Corridor Side Elevation and Reflected Ceiling Plan, see ORAL SURG DWG NO. 12 and 13.

MIL–HDBK–1191 Room Code, DNTP3 DWG NO. 20

Pedodontic DTR Equipment List

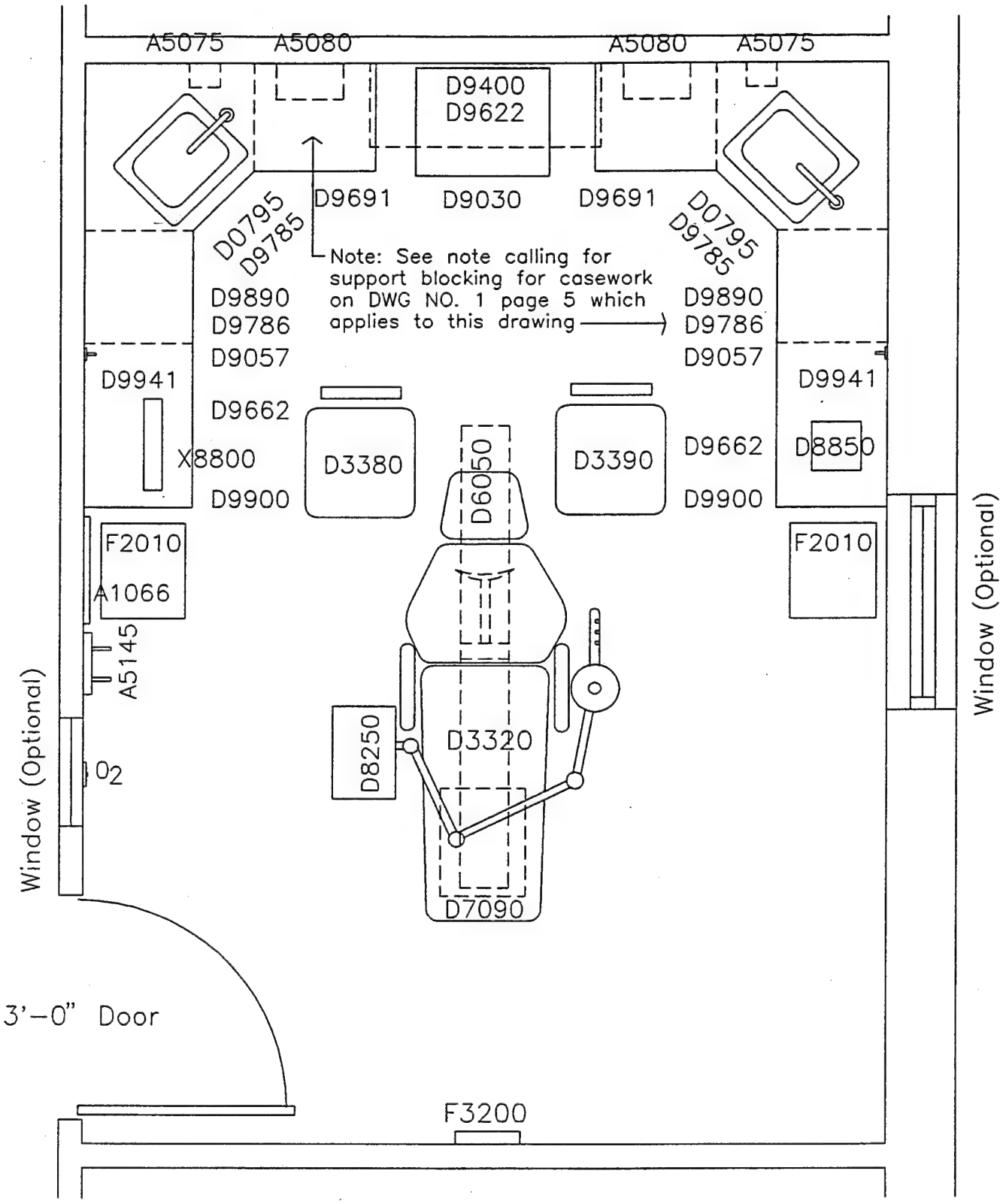
JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A1115	CONSOLE, SERVICE, INFANT, PREFAB
A1161	TRACK, IV, OVAL, CEIL/MNTD, 3FTX7FT
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0100	ANALGESIA UNIT,INHALATION, USES C/UTILS
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6100	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D8850	AMALGAMATOR, DENTAL
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9660	CABINET, BASE, W/H, 2DR, 6.5X19X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
M0610	ANALYZER, OXYGEN, 0-100%
M0765	REGULATOR, VACUUM, C/SYSTEM
M4465	BP CUFF, ELECTRIC
M7715	ELECTROCARDIOGRAPH, PORT, DIRECT WRITING
M7905	OXIMETER
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



Training DTR Floor Plan

Scale: 1/2" = 1' – 0"

MIL–HDBK–1191 Room Code DNTT1 DWG NO. 20a



Training DTR Floor Plan

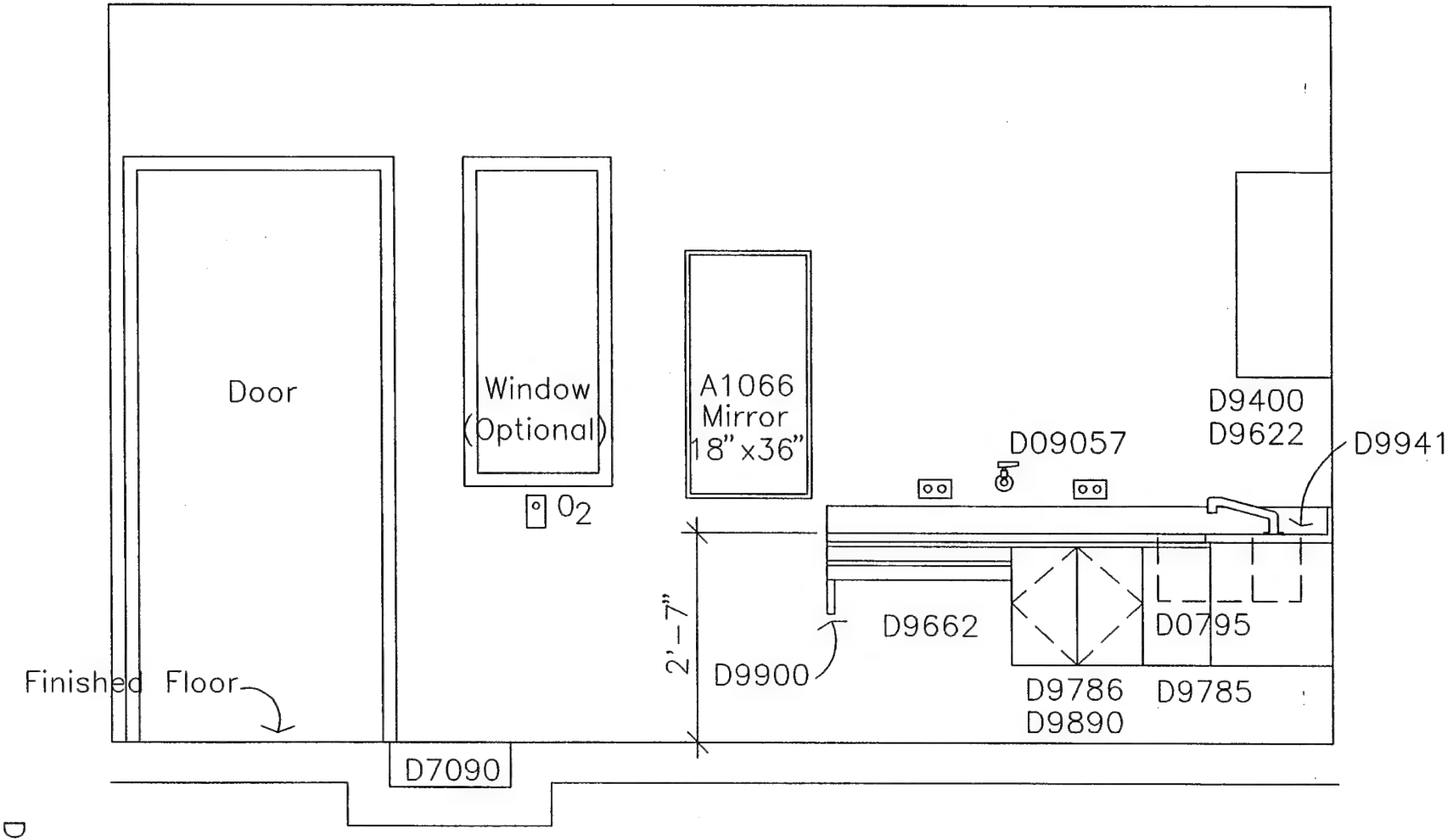
Scale: 1/2" = 1' - 0"

MIL-HDBK-1191 Room Code, DNTT1

DWG NO. 20b

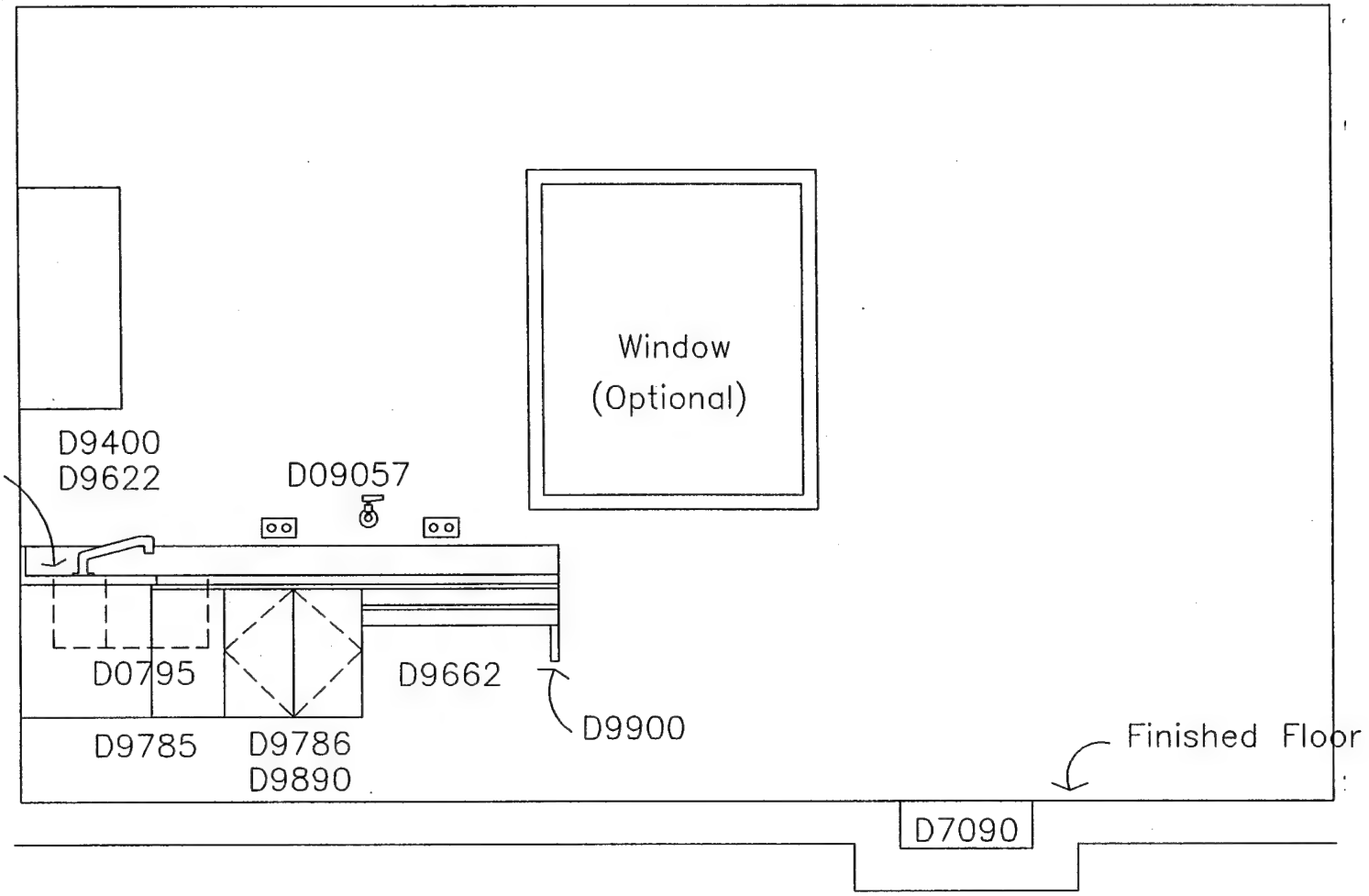
Training DTR Equipment List

JSN	Description
A1066	MIRROR, SS FRAME, 18X36X1/4
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3320	CHAIR, OPERATING, DENTAL, W/UNIT MOUNT
D3380	STOOL, OPERATING, DENTAL, DOCTOR
D3390	STOOL, OPERATING, DENTAL, ASSISTANT
D6050	LIGHT, DENTAL, OPERATING, CEILING, TRACK
D7090	UTILITY CENTER, DENTAL, WALL/FLR MNTD
D8250	UNIT, DENTAL, OPERATING
D8850	AMALGAMATOR, DENTAL
D9030	CABINET, ASSISTANT, DENTAL, MBL,32X22X18
D9057	VALVE, GAS, NEEDLE CONTROL
D9400	CABINET, W/H, 2SDO, 30X38X14
D9622	INSERT, TRAY, TREATMENT, 15X14
D9662	CABINET, BASE, W/H, 2DR, 6.5X27X17
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9785	CABINET,CRNR SINK,W/H,18X27X17
D9786	CABINET, BASE, W/H, 2DO, 18X19X18
D9890	INSERT, TREATMENT, TRAY
D9900	BRACKET, SUPPORT
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
F2010	BASKET, WASTEPAPER, STEP-ON
F3200	CLOCK, BATTERY, 12 DIA
X8800	ILLUMINATOR, FILM, DENTAL, PORTABLE



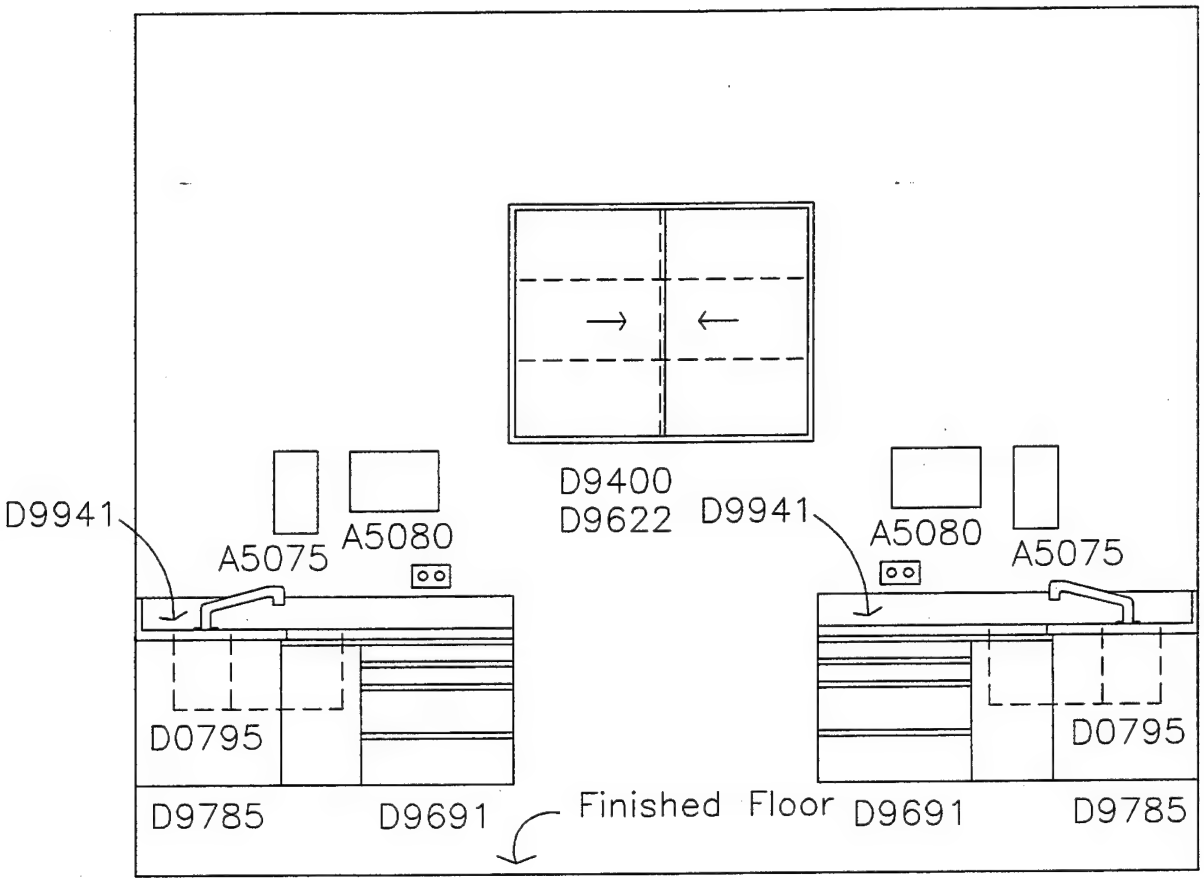
Training DTR Elevation – Left Side

Scale: 1/2" = 1' – 0"



Training DTR Elevation – Right Side

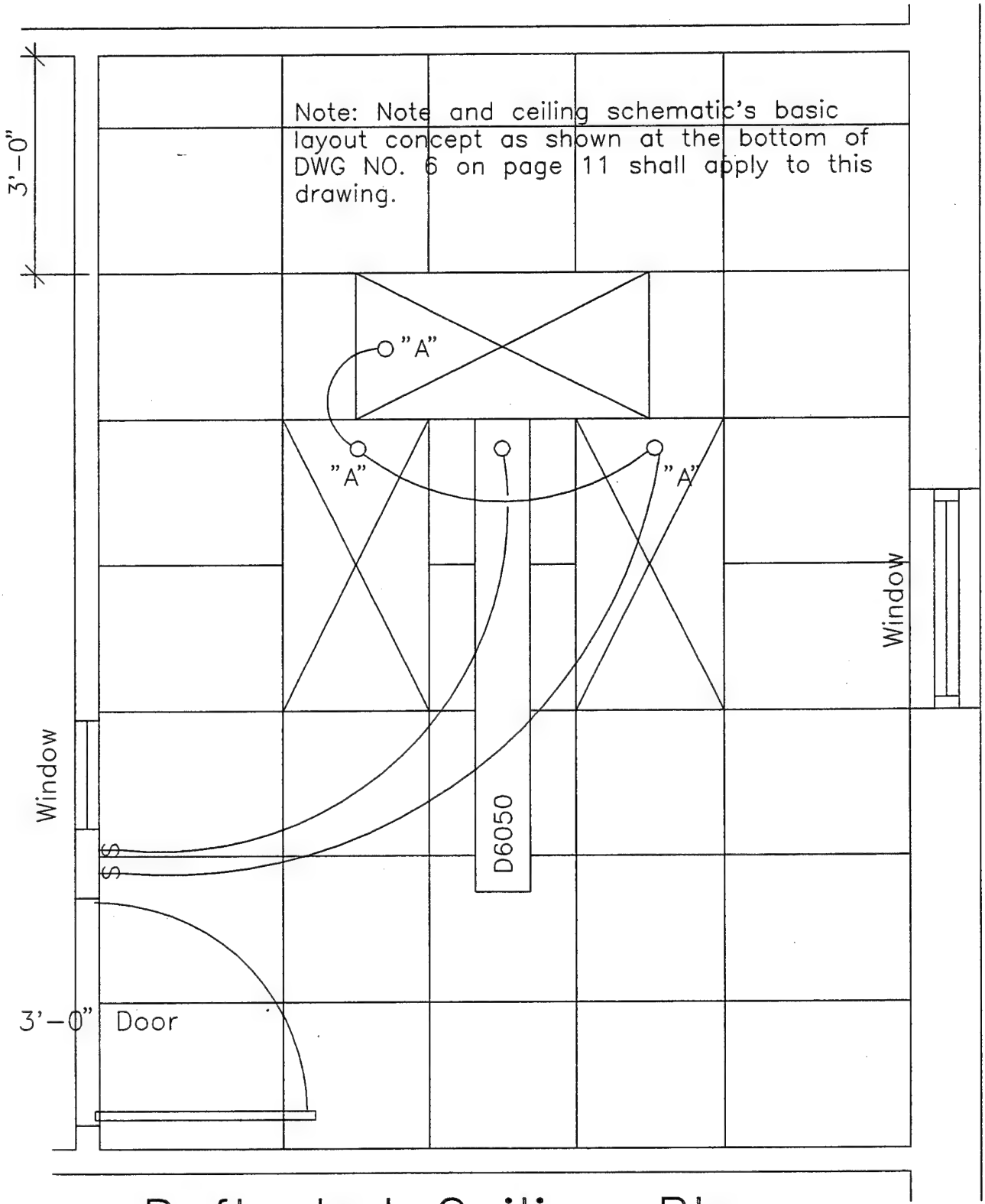
Scale: 1/2" = 1' – 0"



Training DTR Elevation – Rear

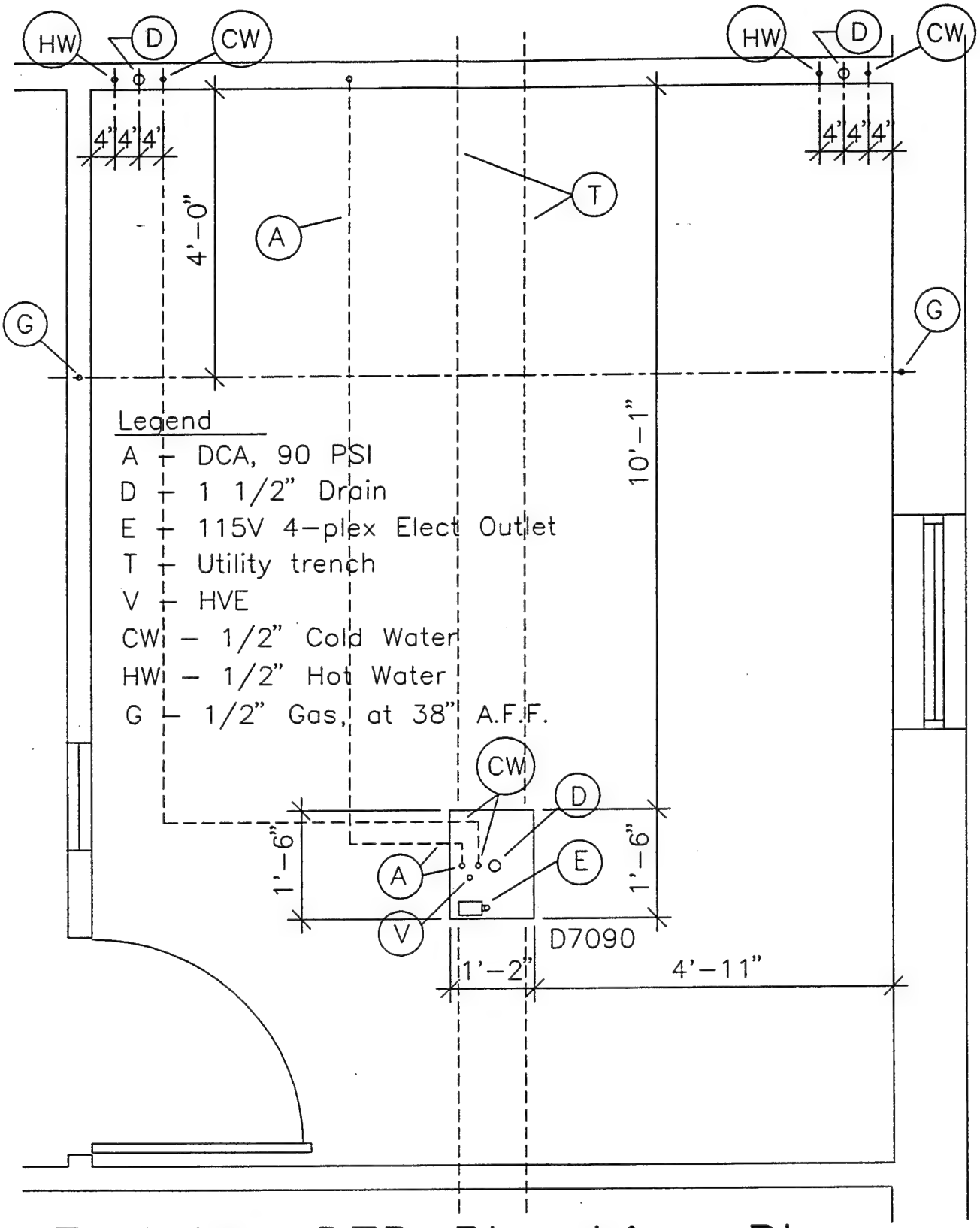
Scale: 1/2" = 1' – 0"

DWG NO. 20e



Reflected Ceiling Plan

Scale: 1/2" = 1' - 0"

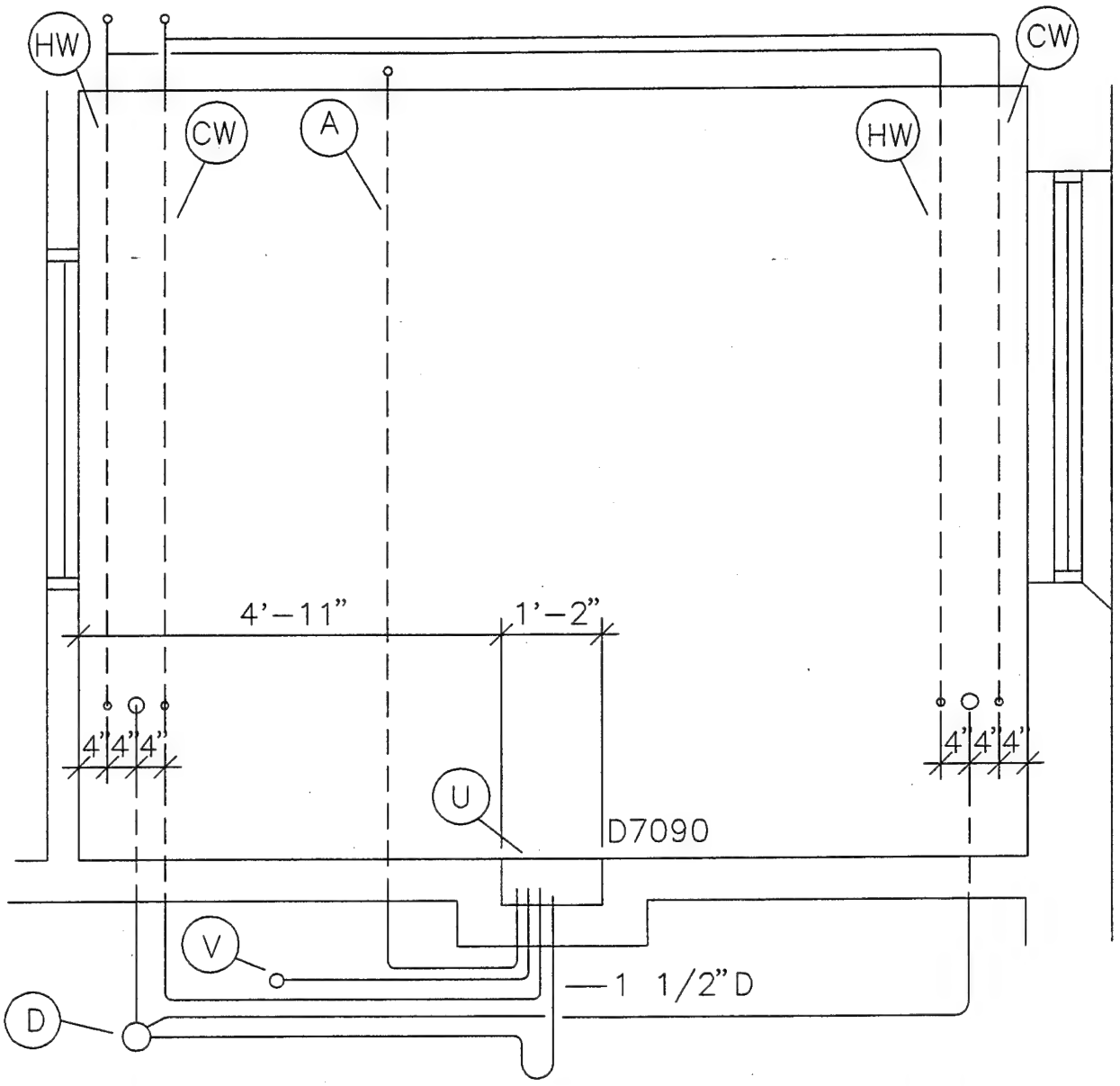


Training DTR Plumbing Plan

Scale: 1/2" = 1' – 0"

Training

DWG NO. 20g



Training DTR Elevation – Rear

Scale: 1/2" = 1' – 0"

Legend

A – DCA, 90 PSI

D – Drain, Main Line

E – 115V 4–plex Elect Outlet

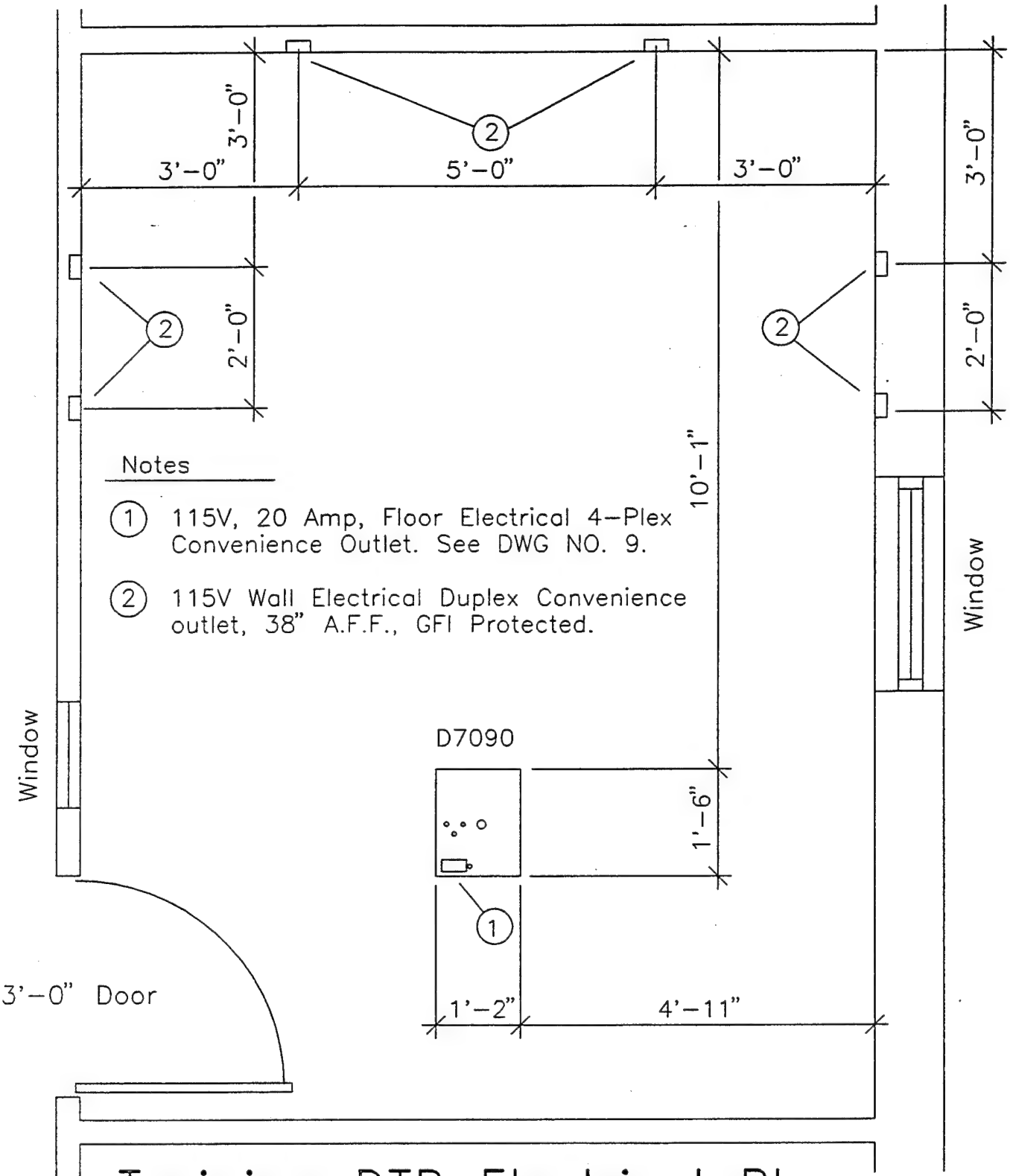
U – Utility Service Center

V – HVE, Main Line

CW – 1/2" Cold Water

HW – 1/2" Hot Water

DWG NO. 20h



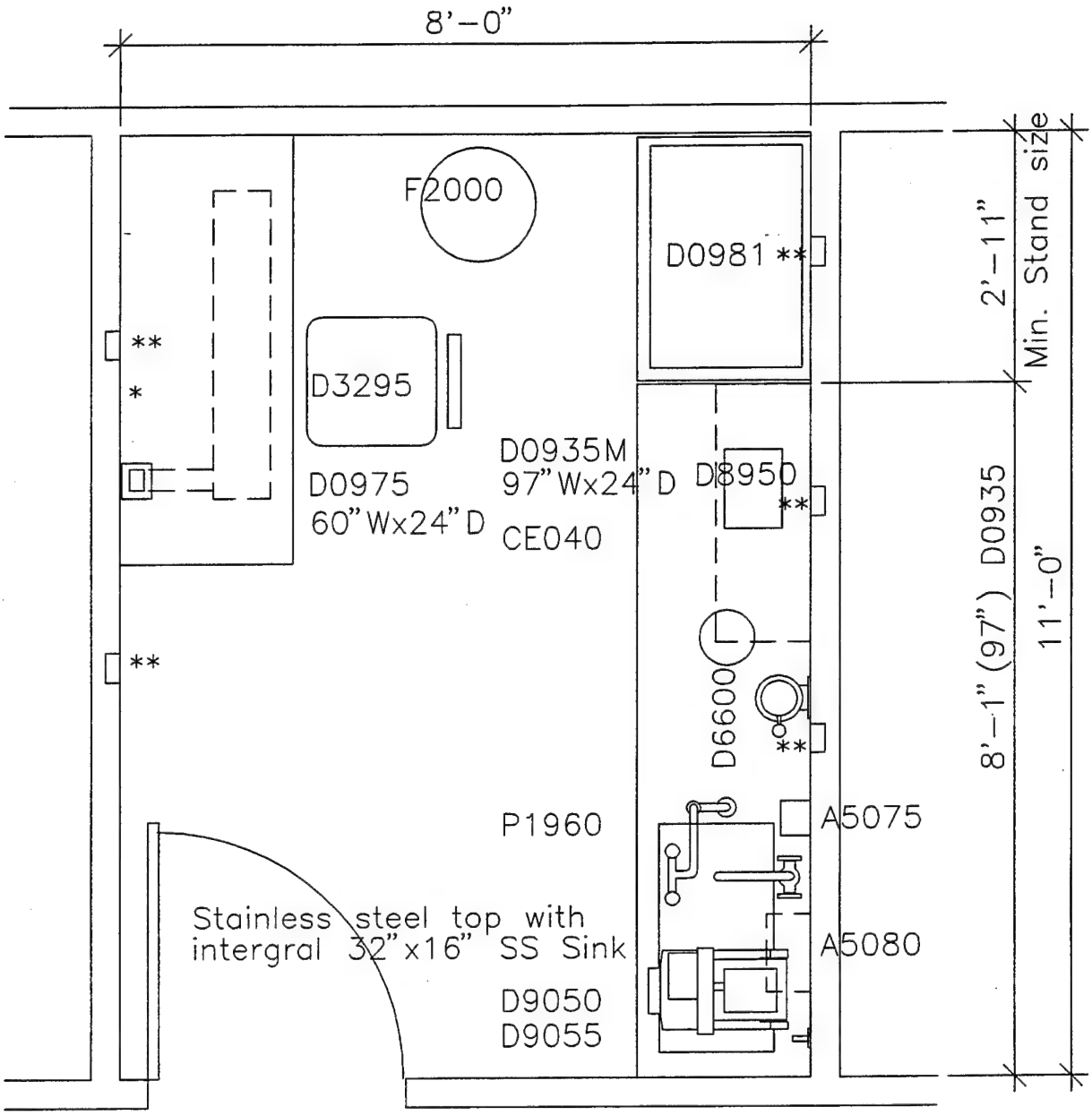
Training DTR Electrical Plan

Scale: 1/2" = 1' - 0"

DWG NO. 20i

Part II

Professional Work Area



Professional Work Area Floor Plan

Scale: 1/2" = 1' - 0"

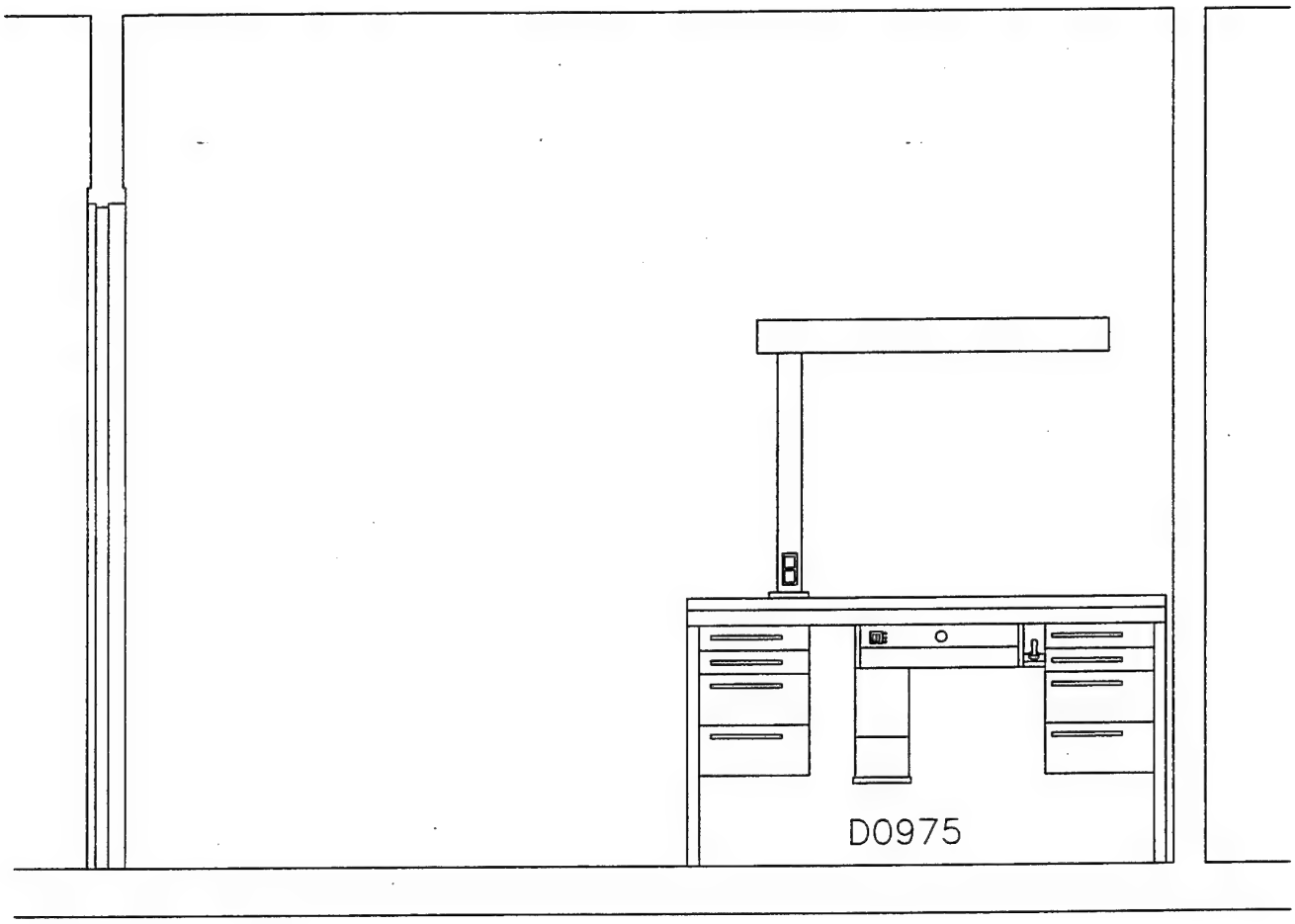
*Provide 1/2" air and gas stub-outs on wall below counter top for hard connection to D0975

**Provide 115V duplex convenience outlet, located below D0975 counter top and above D0935M counter top splash. Provide GFI protection at D0935.

MIL-HDBK-1191 Room Code, DNWA1 DWG NO. 21

Professional Work Area Equipment List

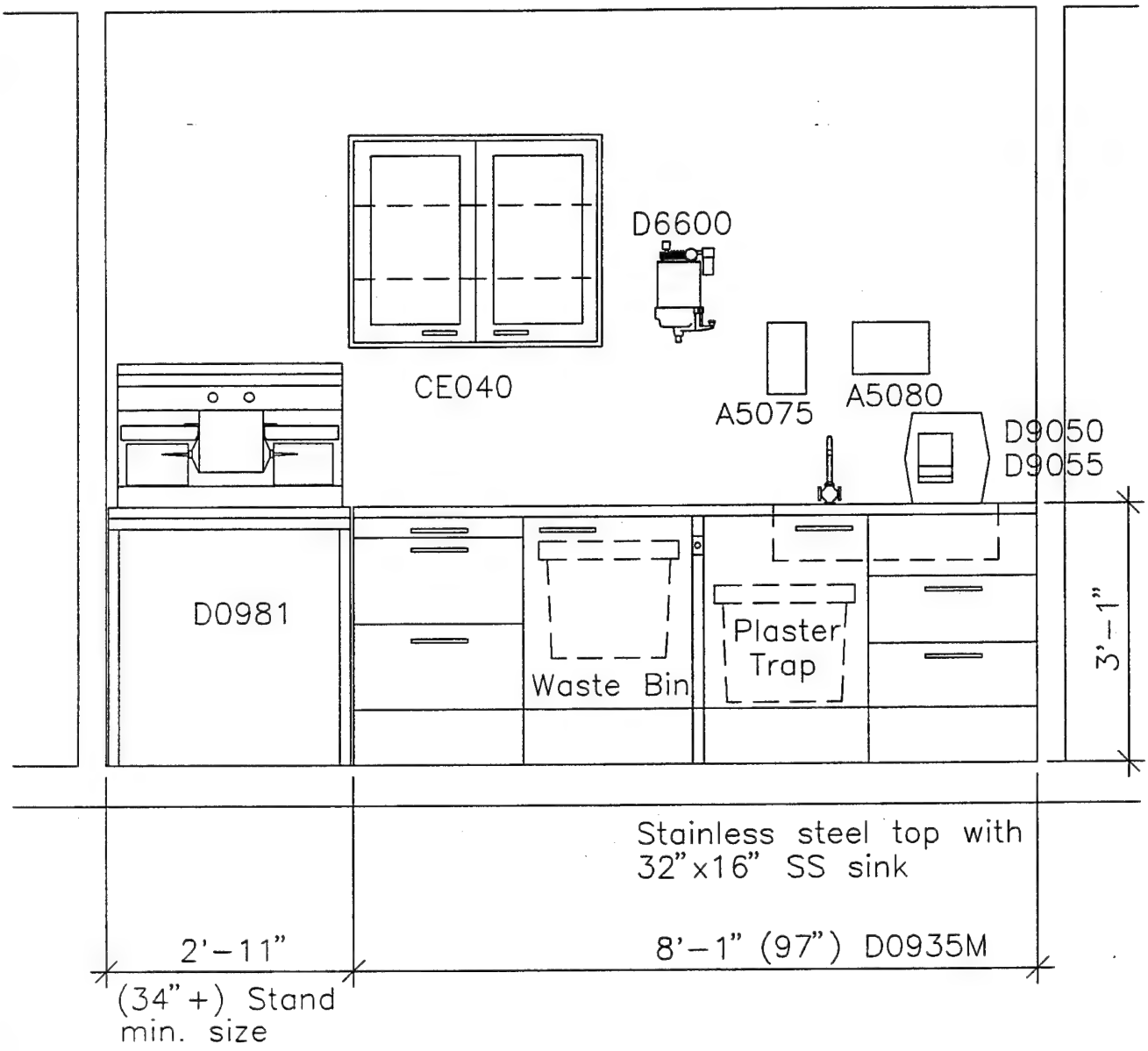
JSN	Description
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
CE040	CABINET, W/H, 2GDO, 2SH, 30X36X13
D0935	WORKSTATION, DENT LAB,INVEST,97WX24DX37H
D0975	WORKSTATION, DENT LAB, DIE TRIMMING
D0981	WORKSTATION, POLISHING BOX, ON SS STAND
D3295	CHAIR, ROTARY, LABORATORY, DENTAL
D6600	MIXER/INVESTOR, VACUUM, 2SP, 1/3HP
D8950	VIBRATOR, MOLDING, DENTAL
D9050	TRIMMER, MODEL, DENTAL, 1/4HP, 13x13x16
D9055	VALVE, TRIMMER, MODEL, DENTAL
F2000	BASKET, WASTEPAPER, ROUND,METAL,18X16DIA
P1960	STATION, WASH, EYE/FACE, COUNTER TOP



Prof. Work Area Elev. – Left Side

Scale: 1/2" = 1' – 0"

DWG NO. 22



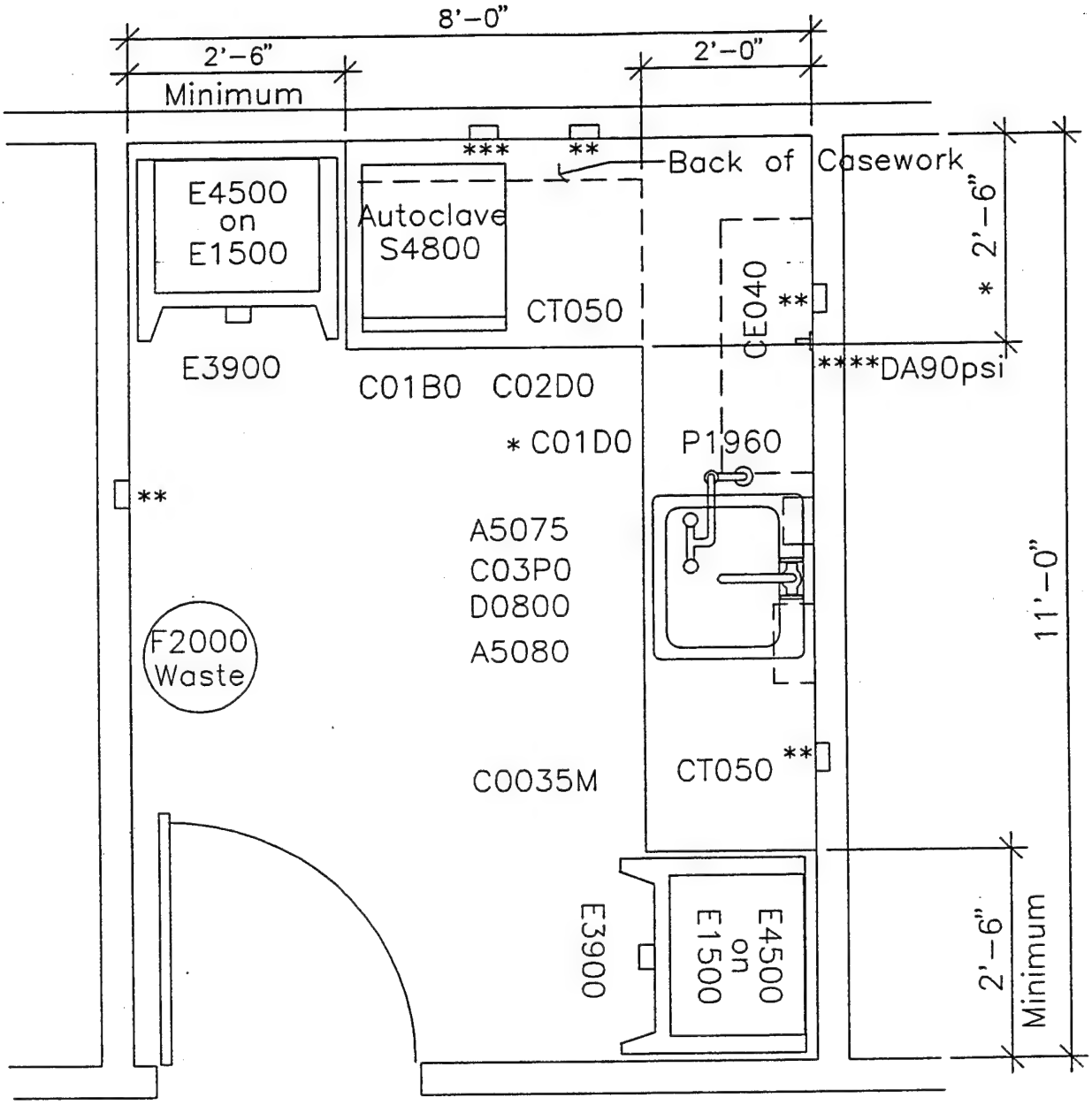
Prof. Work Area Elev. – Right Side

Scale: 1/2" = 1' - 0"

DWG NO. 23

Part III

DTR Support Room
(Individual Suite Sterilization Room)



DTR Support Room for Individual Suites Floor Plan

Scale: 1/2"=1'-0"

*In most cases, contemporary table top sterilizers are a depth that is small enough to allow for a 2'-0" deep counter top. If this is the case in the Users situation, we recommend that in lieu of 2'-6", a 2'-0" counter top be used, and C02D0 drawer unit be installed to the left of the sink unit rather than C01D0.

**115V electrical duplex convenience outlet (above counter top splashes).

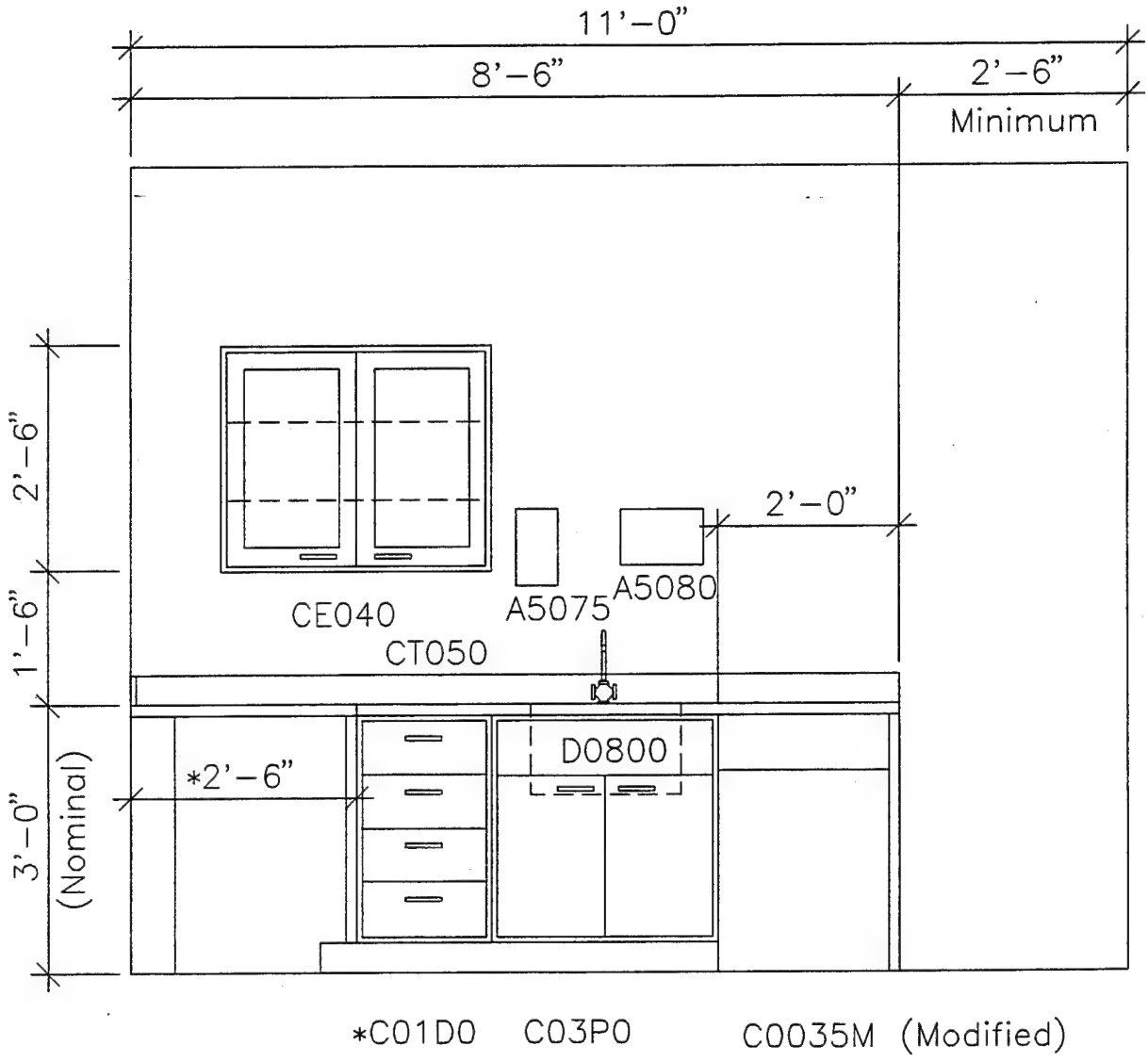
***115V, 30 amp electrical outlet on a dedicated circuit for S4800. Locate above counter top splash.

****Dental air, 90PSI, with quick disconnet. See attached recommended quick disconnect detail drawing. Locate above counter top splash.

MIL-HDBK-1191 Room Code, DNSA1 DWG NO. 24

DTR Support Room Equipment List

JSN	Description
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
C0035	RAIL, APRON, 5.5X24X22
C01B0	CABINET, U/C/B, DO, 2SH, 36X18X22
C01D0	CABINET, U/C/B, 4DR, 36X18X22
C02D0	CABINET, U/C/B, 4DR, 36X24X22
C03P0	CABINET, U/C/B, SINK, 2DO, 36X30X22
CE040	CABINET, W/H, 2GDO, 2SH, 30X36X13
CT050	COUNTERTOP, CRS,
D0800	SINK, SS, 12X20X16
E1500	RAIL, MOD, W/MNTD, HX144XD
E3900	CART, TRANSPORT, 1 LOCKER, 42X28X26
E4500	LOCKER, STORAGE, MOD, R/H, 66X23X20
F2000	BASKET, WASTEPAPER, ROUND,METAL,18X16DIA
P1960	STATION, WASH, EYE/FACE, COUNTER TOP
S4800	STERILIZER, INSTRUMENT, ELEC, CTR/MNTD

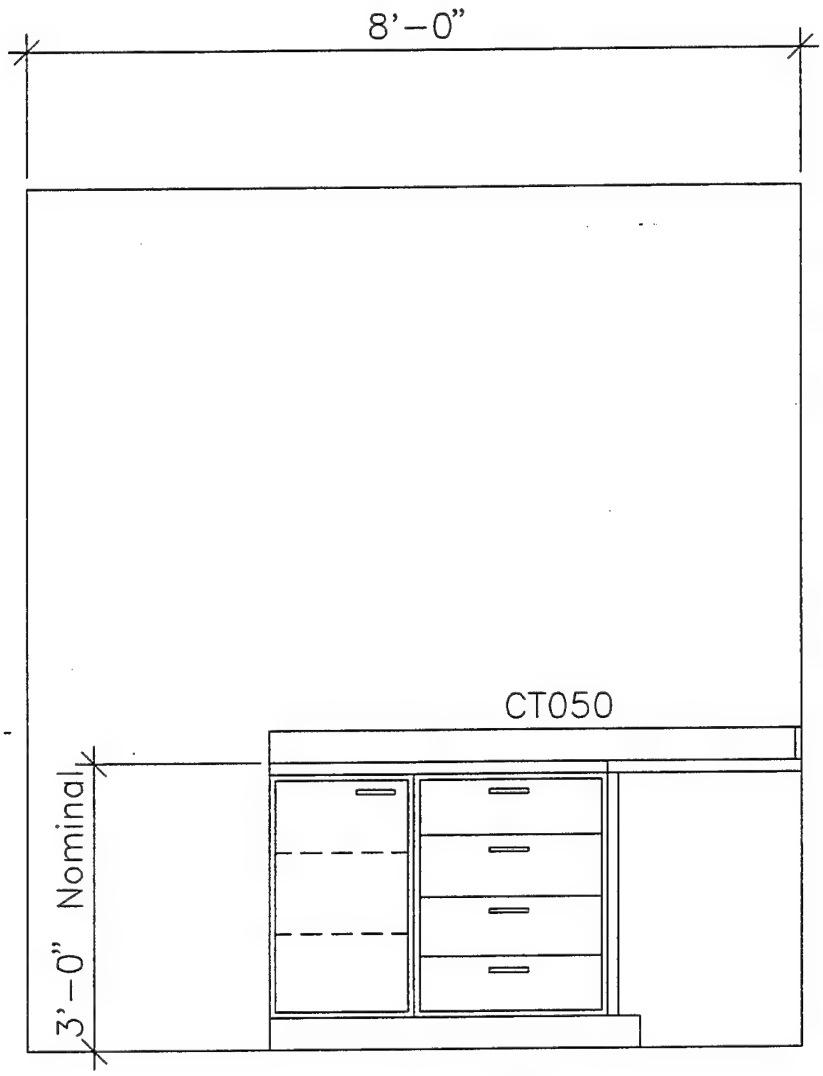


DTR Support Room for Individual Suites Right Elevation

Scale: 1/2" = 1'–0"

* See Note at bottom of Drawing No. 24.

DWG NO. 25



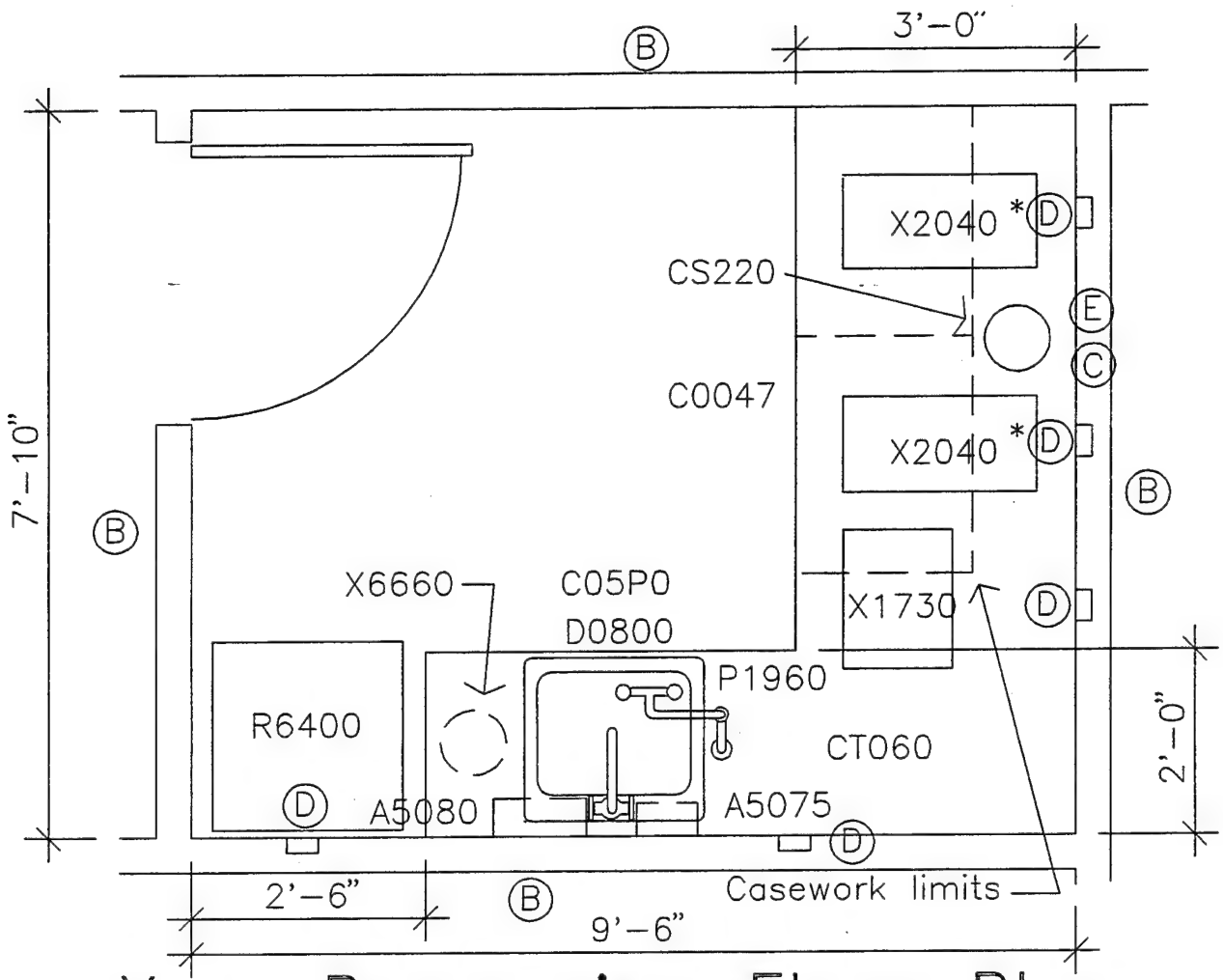
DTR Support Room for Individual Suites Rear Elevation

Scale: 1/2"=1'-0"

DWG NO. 26

Part IV

Xray Processing Room



Xray Processing Floor Plan

Scale: 1/2"=1'-0"

(A) Note that safe light X6660 shall be located no closer than a horizontal distance of 48 inches from either processor.

(B) Note that additional lead shielding thickness may be required on walls between Xray Processing and Xray Rooms to protect the stored Xray film in Xray Processing. The facility designer shall follow the requirements of NCRP 49 to ascertain the lead thickness required for these walls, and send copies of design results to AL/OEBZ, 2402 East Drive, Brooks AFB, TX 78235 for their approval.

(C) Provide hot and cold water with mixing valve with thermostatic control for processors.

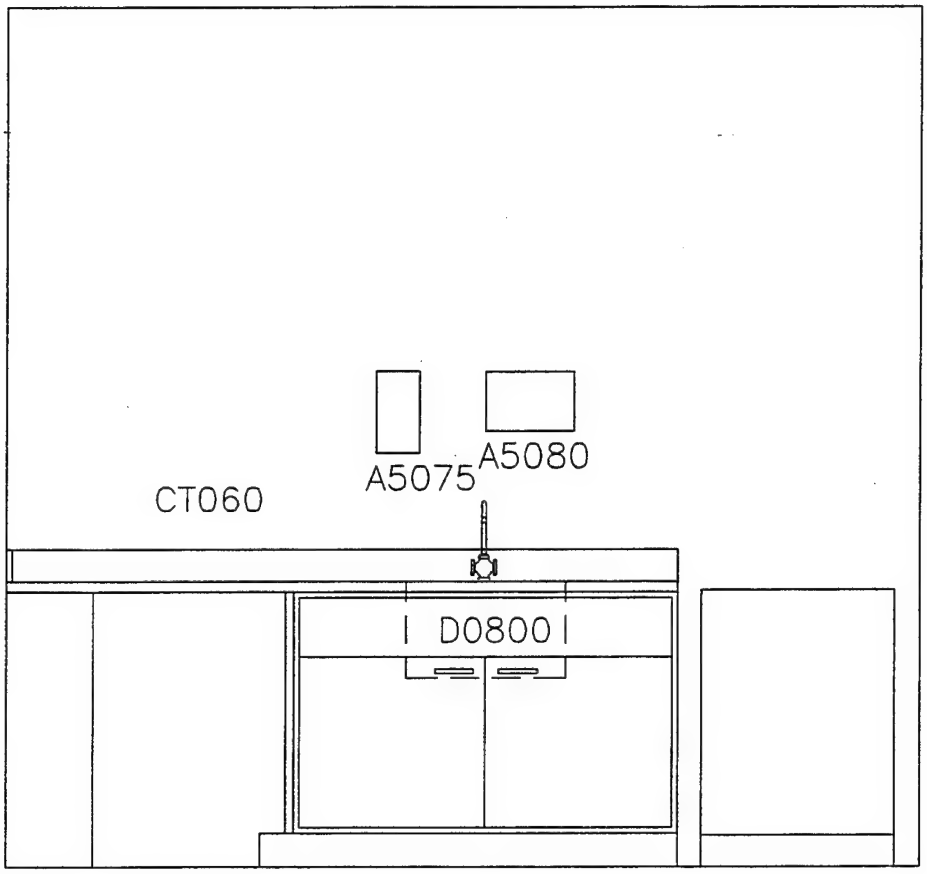
*(D) 115V electrical duplex convenience outlet (located above splashes at counter tops). *Also provide one outlet below near floor for Silver Recovery Unit.

(E) Provide 1 1/2 inch drain for CS220 (processor drain sink).

MIL-HDBK-1191 Room Code, DNXF2 DWG NO. 27

Xray Processing Equipment List

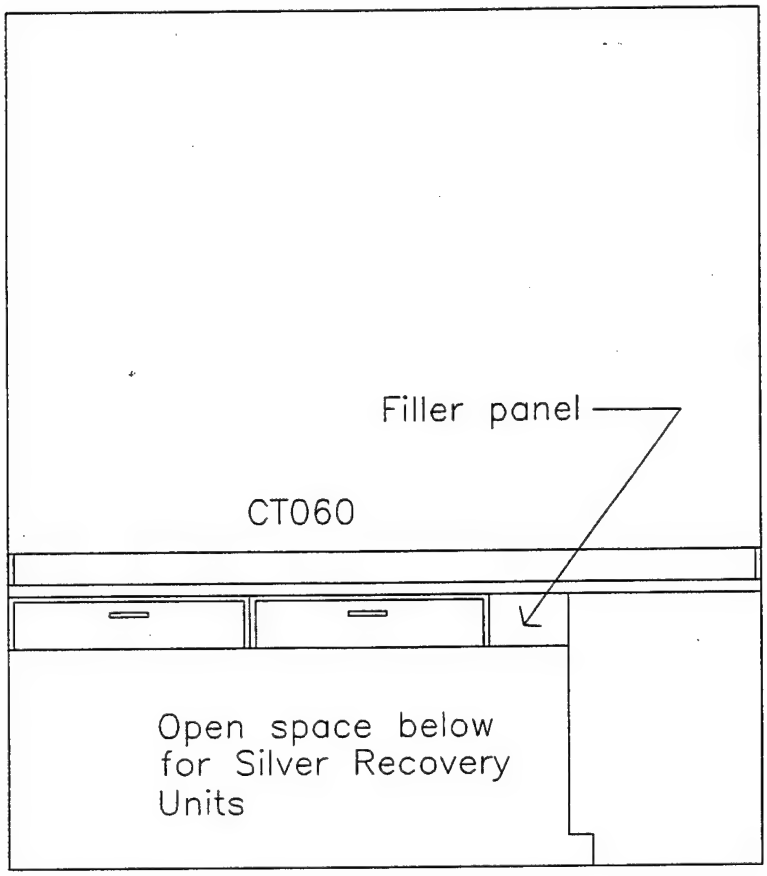
JSN	Description
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
C0047	FRAME, APRON, 2DR, 5.5X60X22
C05P0	CABINET, U/C/B, SINK, 2DO, 36X48X22
CS220	SINK, COUNTER, CUP
CT060	COUNTERTOP, MODIFIED EPOXY RESIN
D0800	SINK, SS, 12X20X16
P1960	STATION, WASH, EYE/FACE, COUNTER TOP
R6400	REFRIGERATOR, 35X24X24, 4CUFT
X1730	DUPLICATOR, FILM, DENTAL, 9X18X14
X2040	PROCESSOR, FILM, DENTAL
X6660	SAFELIGHT, DARKROOM, CEILING MOUNTED



Xray Processing Sink Wall Elev

Scale: 1/2"=1'-0"

DWG NO. 28



C0047

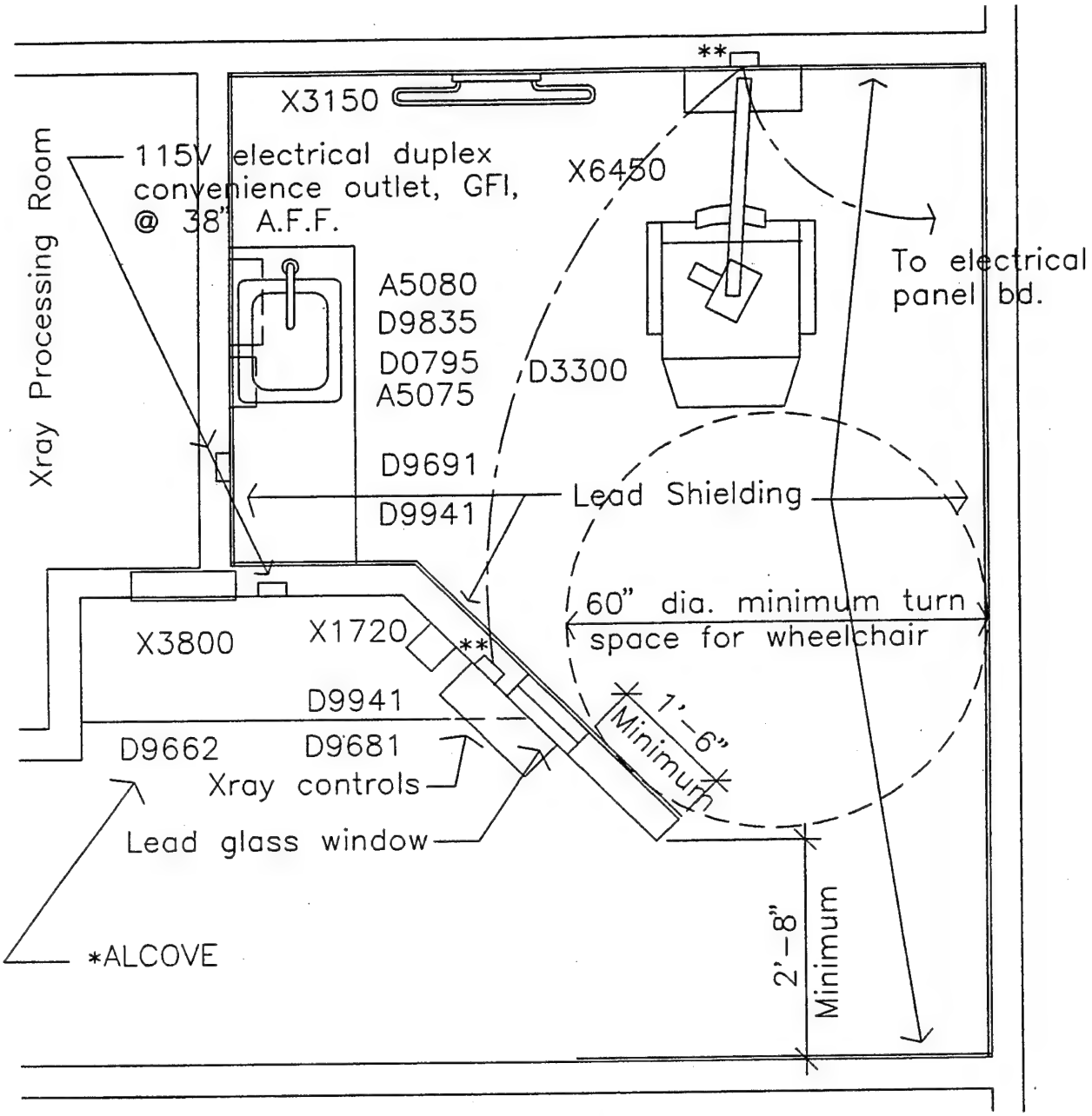
Xray Processing Processor Wall Elevation

Scale: 1/2"=1'-0"

DWG NO. 29

Part V

Standard Xray Room



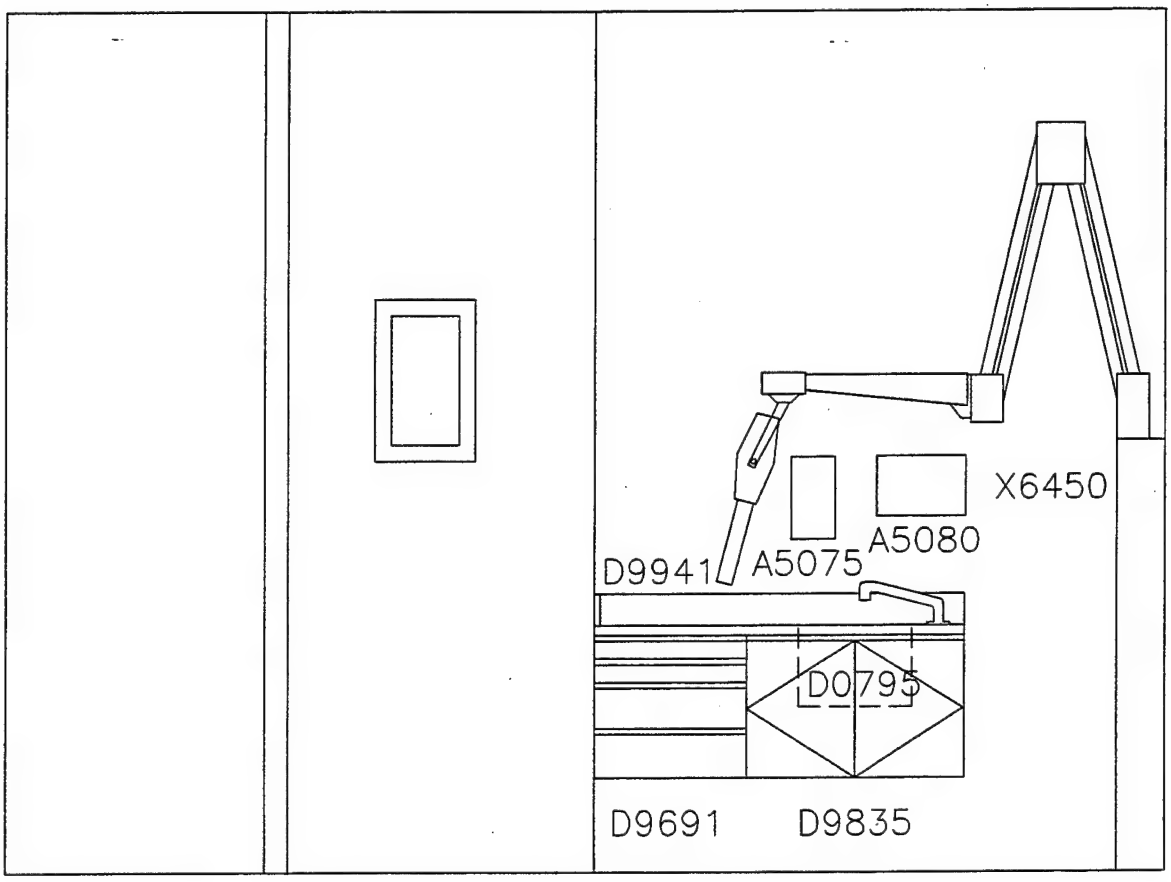
Standard Xray Room Floor Plan

Scale: 1/2"=1'-0"

*ALCOVE. The Alcove is not part of an individual Xray Room, and is shown here only as a possible/suitable location for an Xray suites Alcove location. This space would be used in Xray suites as a centrally located Alcove for Doctors use to view Xray films on a wall recessed illuminator and perform other required paper work.

**In addition to required electrical power wire and conduit for power supply to the Xray equipment, the project designer shall provide required conduit, J-boxes, and other miscellaneous wire to be used by the Xray equipment supplier.

MIL-HDBK-1191 Room Code, DNXI1 DWG NO. 30



Standard Xray Room Elevation

Scale: 1/2"=1'-0"

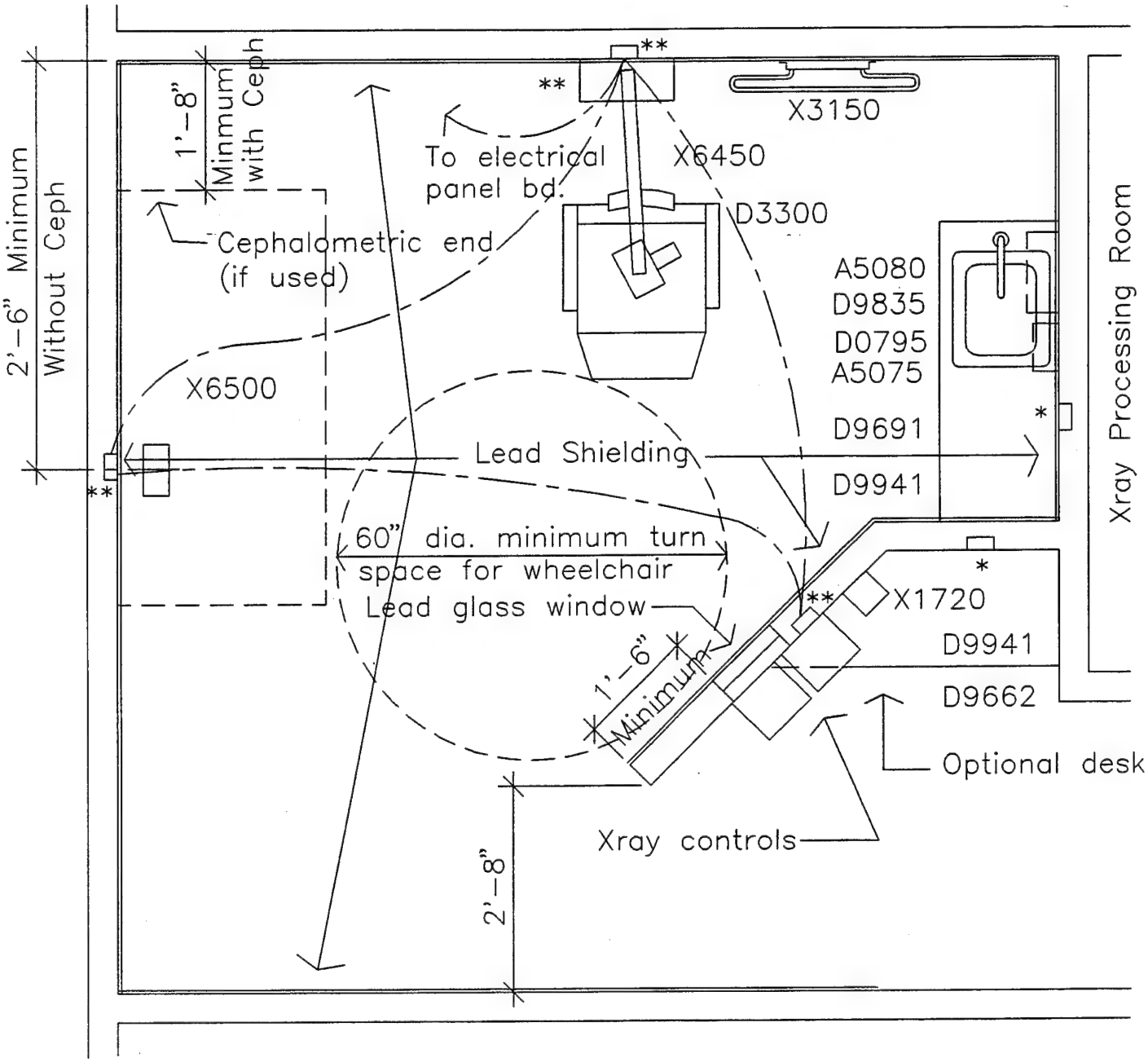
DWG NO. 31

Standard Xray Room Equipment List

JSN	Description
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3300	CHAIR, RADIOGRAPHIC, DENTAL
D9662	CABINET, BASE, W/H, 2DR, 6.5X27X17
D9681	CABINET, BASE, W/H, 3DR, 17X19X18
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
X1720	SAFE, FILM, X-RAY, DENTAL, 2CMPT
X3150	RACK, APRON/GLOVES, WALL MOUNTED
X3800	ILLUMINATOR, FILM, SNGL, RCSD, 20X15X5
X6450	RADIOGRAPHIC UNIT, DENTAL, W/MNTD, 15 MA

Part VI

Standard Xray Room
with
Panograph



Standard Xray Room Floor Plan With Panograph

Scale: 1/2"=1'-0"

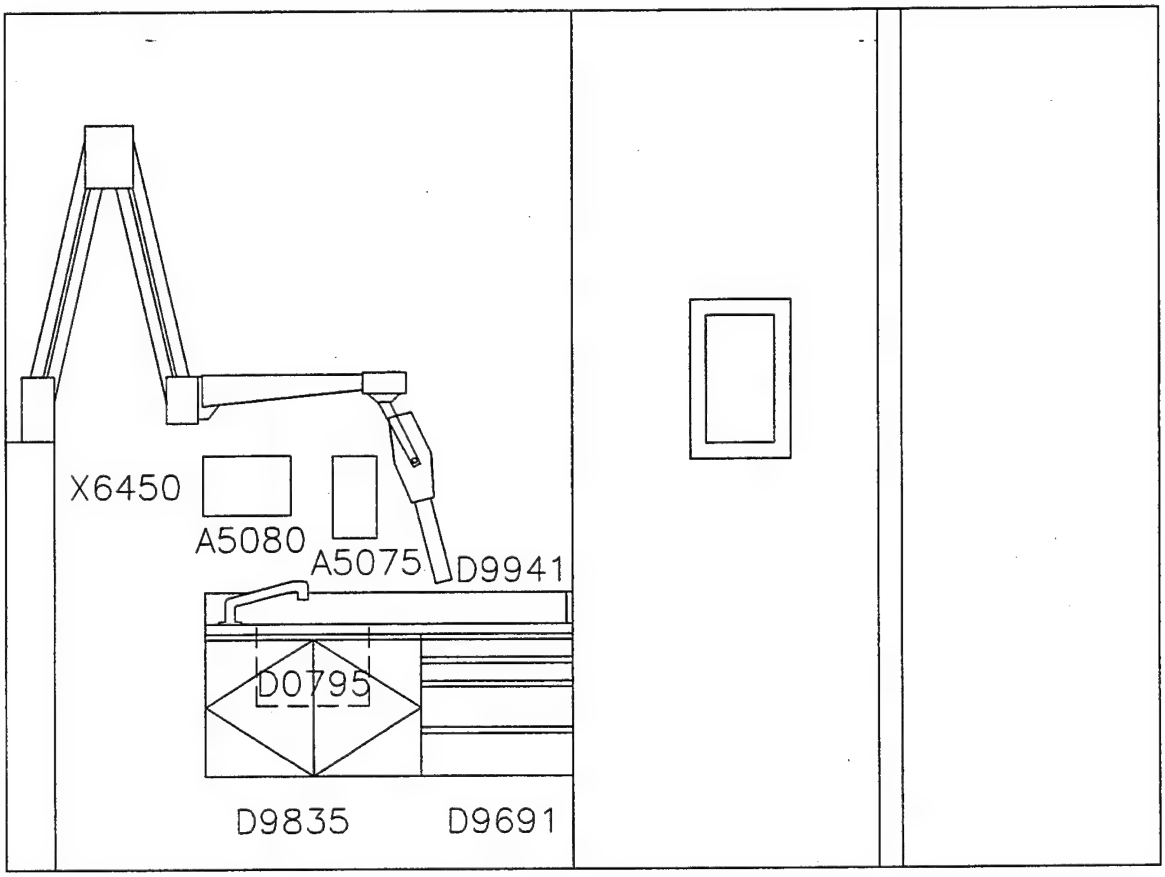
*115V electrical duplex convenience outlet, GFI, @ 38" A.F.F.

**See note on DWG NO. 30 refering to equipment power supply wiring, conduit, and J-boxes.

MIL-HDBK-119 Room Code, DNXD1 DWG NO. 32

Standard Xray Room with Panograph Equipment List

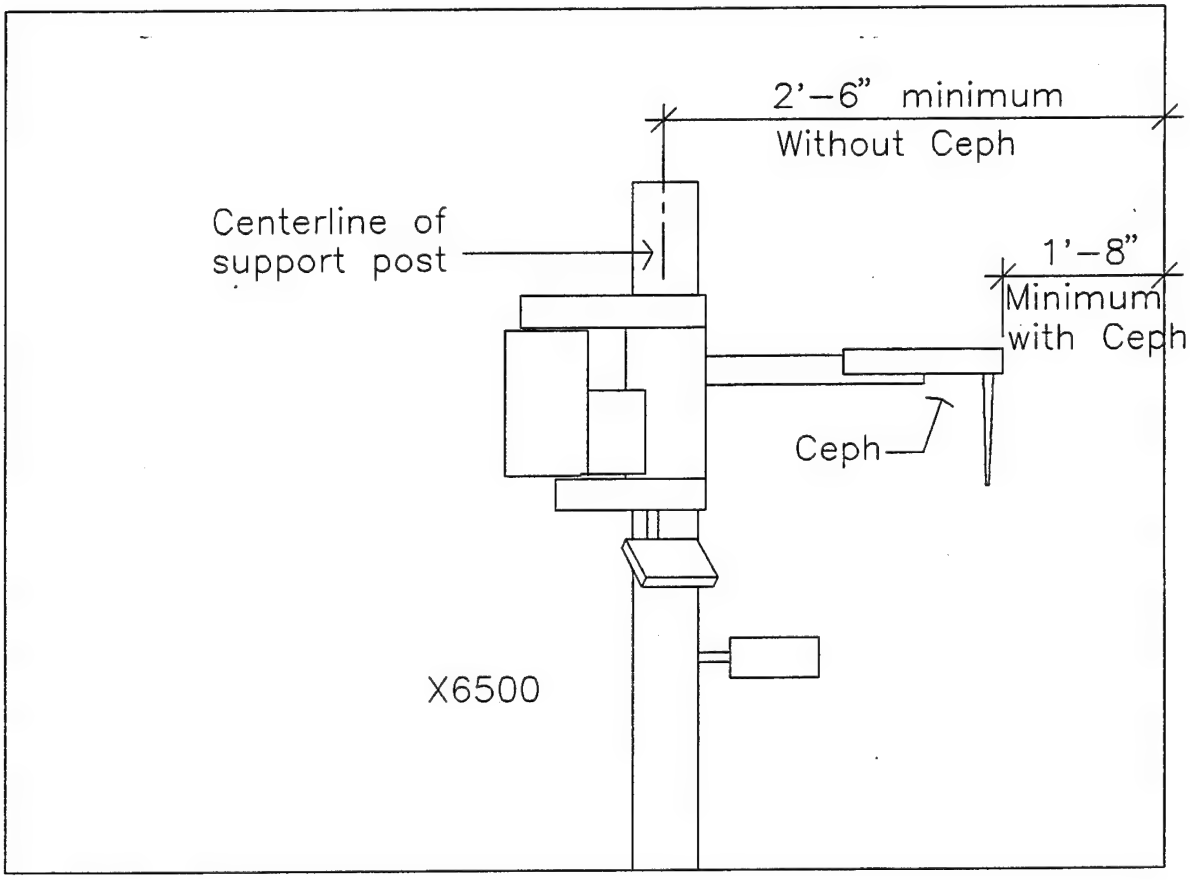
JSN	Description
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
D0795	SINK, CRS, 18 GA, 10X14X10, FOOT CONTROL
D3300	CHAIR, RADIOGRAPHIC, DENTAL
D9662	CABINET, BASE, W/H, 2DR, 6.5X27X17
D9681	CABINET, BASE, W/H, 3DR, 17X19X18
D9691	CABINET, BASE, W/H, 4DR, 22X20X18
D9835	CABINET, BASE, SINK,W/H,2DO,17X27X18
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
X1720	SAFE, FILM, X-RAY, DENTAL, 2CMPT
X3150	RACK, APRON/GLOVES, WALL MOUNTED
X3800	ILLUMINATOR, FILM, SNGL, RCSD, 20X15X5
X6450	RADIOGRAPHIC UNIT, DENTAL, W/MNTD, 15 MA
X6500	RADIOGRAPHIC UNIT, DENTAL, PANOGRAPHIC



Standard Xray Room Elevation With Panograph (VIEW LOOKING AT CASEWORK)

Scale: 1/2"=1'-0"

DWG NO. 33



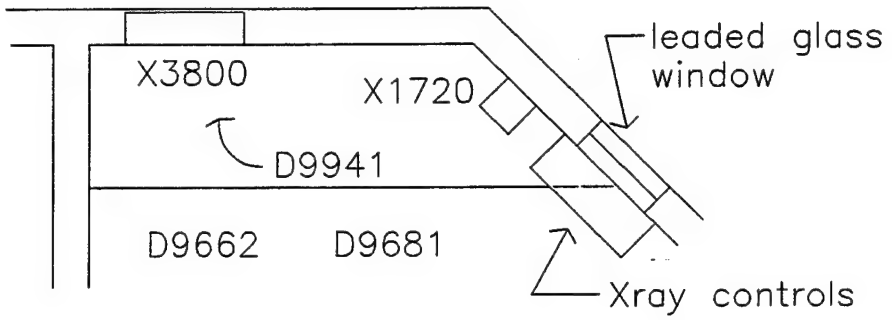
Standard Xray Room Elevation With Panograph (VIEW LOOKING AT PANOGRAPH)

Scale: 1/2"=1'-0"

DWG NO. 34

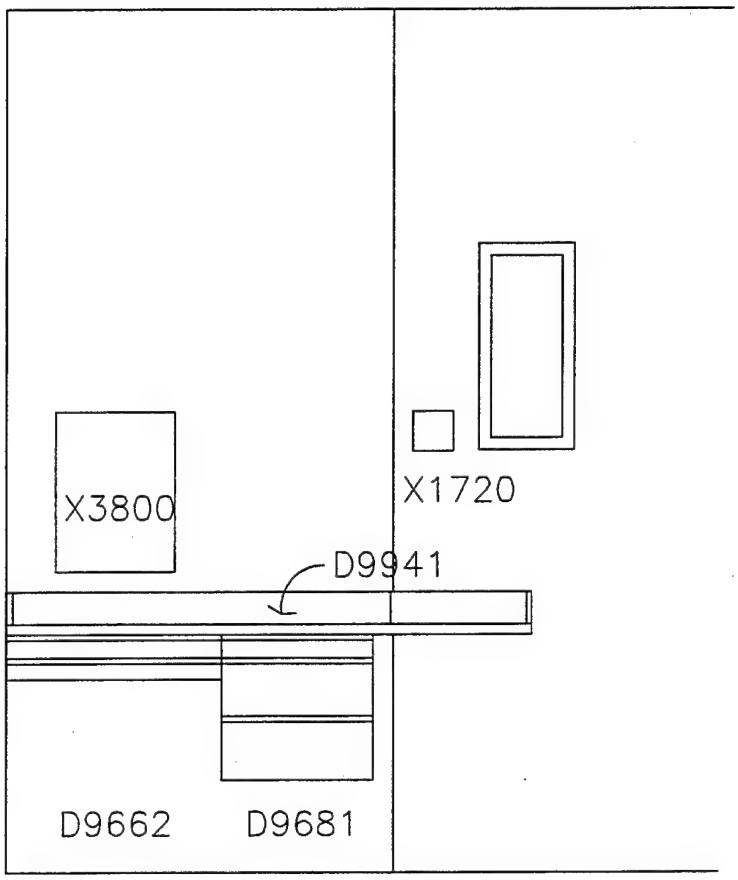
Part VII

Xray Alcove Area



Xray Alcove Floor Plan

Scale: 1/2" = 1' – 0"



Xray Alcove Elevation

Scale: 1/2" = 1' – 0"

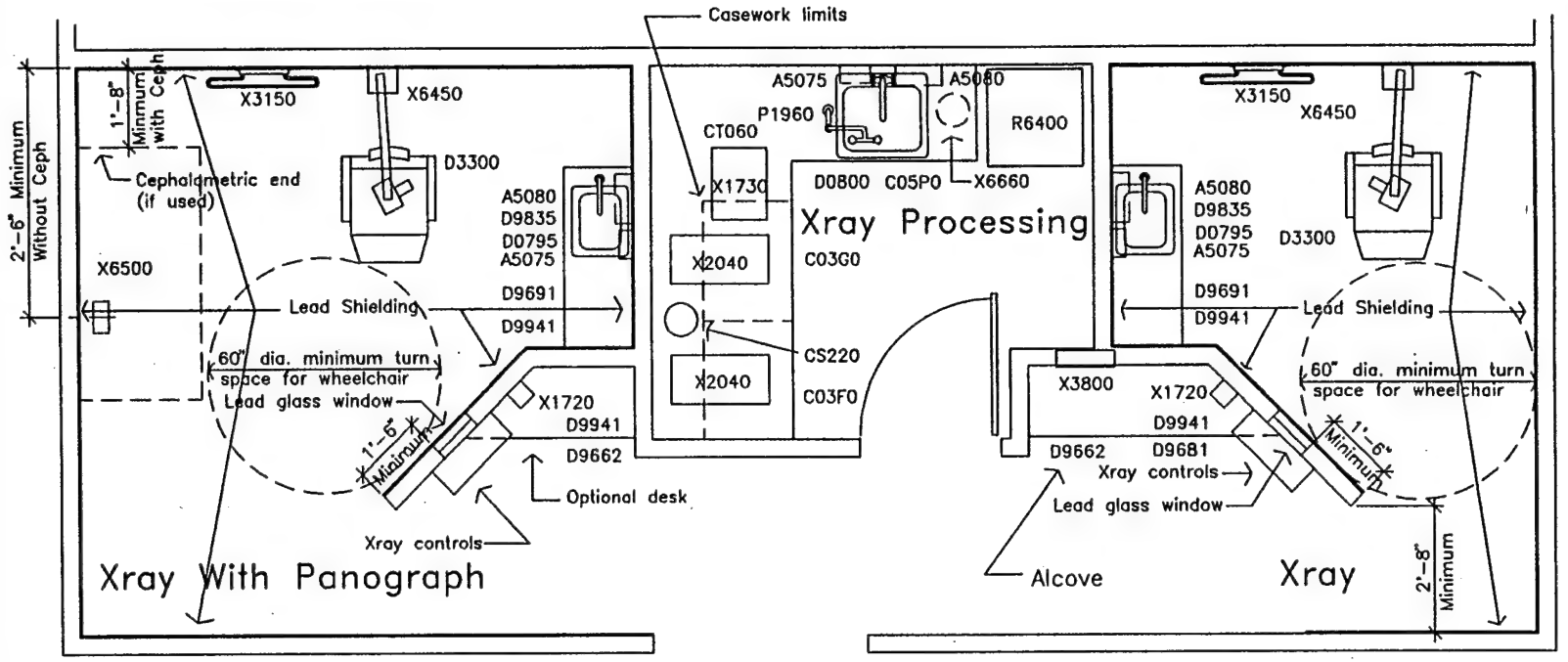
MIL–HDBK–1191 Room Code, DNXR1 DWG NO. 35

Xray Alcove Area Equipment List

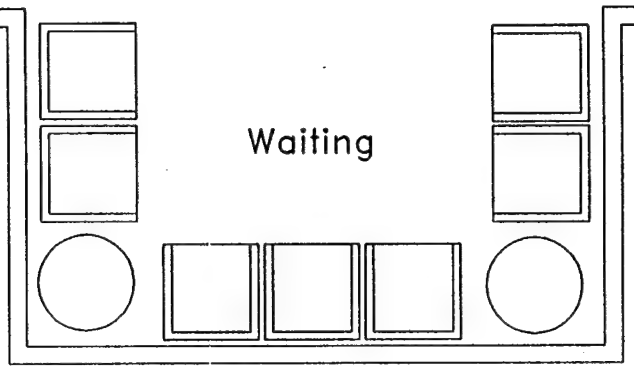
JSN	Description
D9662	CABINET, BASE, W/H, 2DR, 6.5X27X17
D9681	CABINET, BASE, W/H, 3DR, 17X19X18
D9941	COUNTERTOP, LAMINATED, .75XWX17.5
X1720	SAFE, FILM, X-RAY, DENTAL, 2CMPT
X3800	ILLUMINATOR, FILM, SNGL, RCSD, 20X15X5

Part VIII

Standard Xray Suite



Corridor



Standard Xray Suite

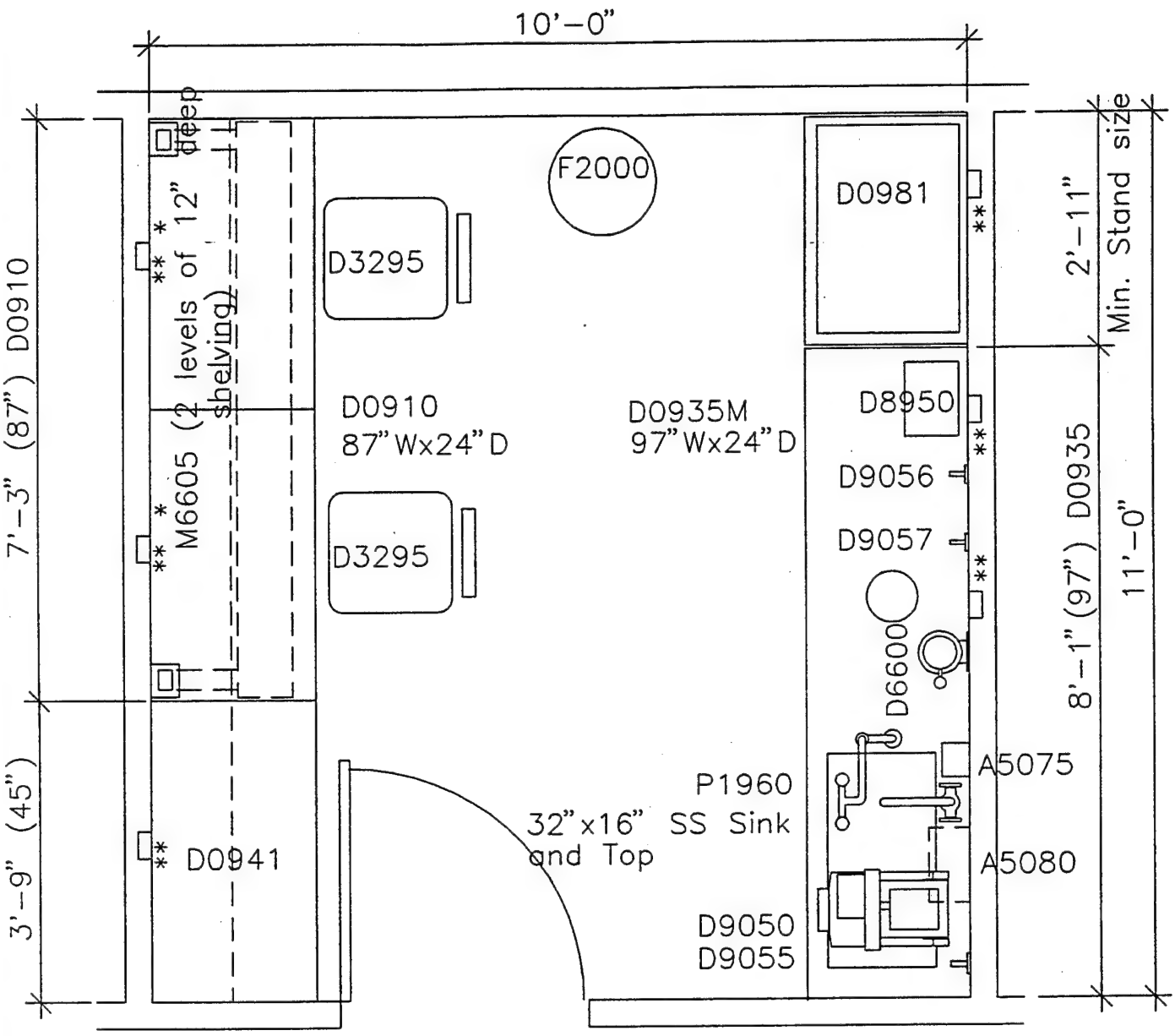
Scale: 1/4"=1'-0"

MIL-HDBK-1191 Room Codes, DNXD1, DNXF2, DNXR1, and DNXI1

DWG NO. 36

Part IX

Orthodontics Laboratory



Orthodontic Laboratory Floor Plan

Scale: 1/2" = 1' - 0"

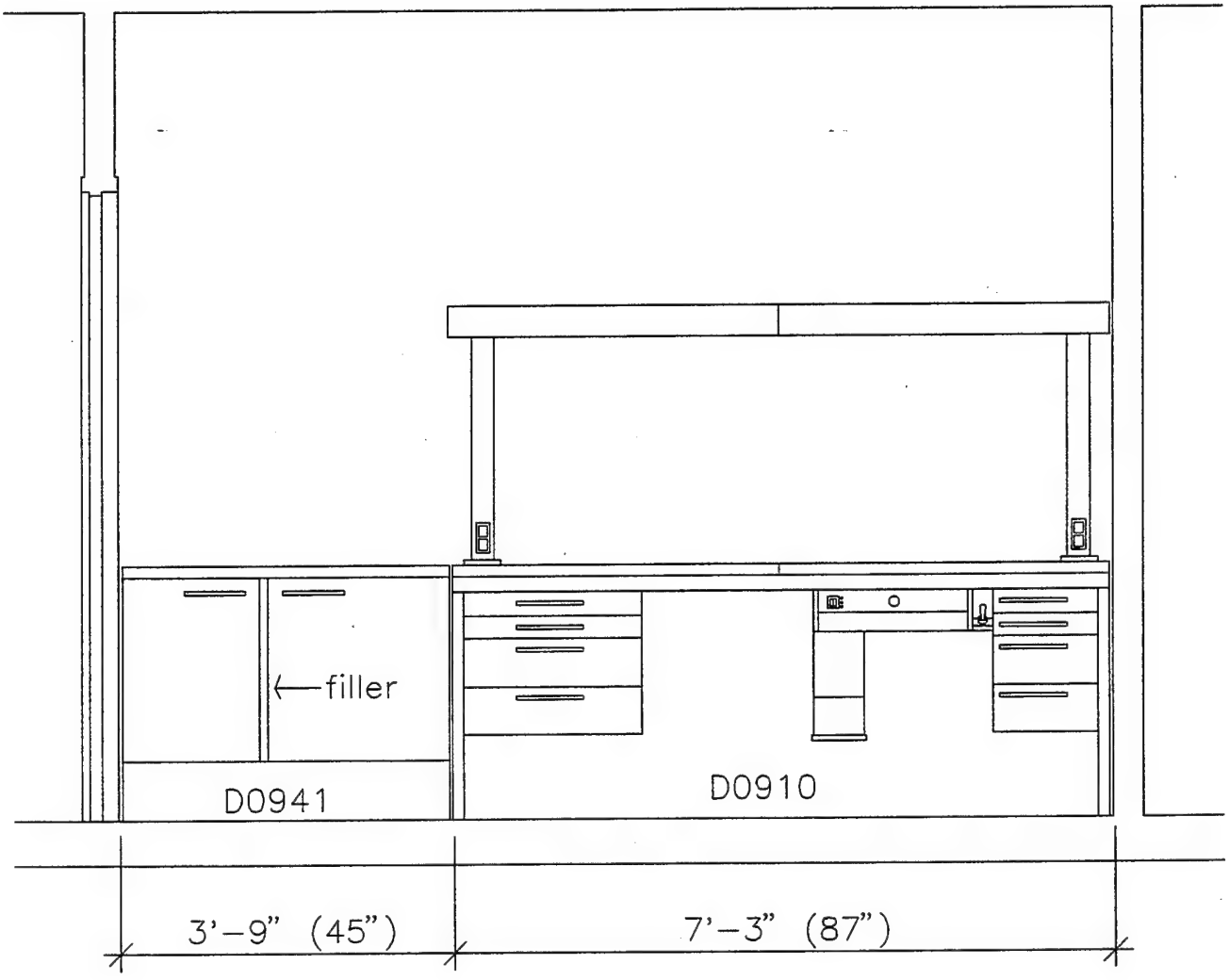
*Provide 1/2" air and gas stub-outs on wall below counter top for hard connection to D0910.

**Provide 115V electrical duplex convenience outlets, located below D0910 counter top, and above D0935M and D0941 counter tops. Provide GFI protection at D0935M.

MIL-HDBK-1191 Room Code, DNPB1 DWG NO. 37

Orthodontic Laboratory Equipment List

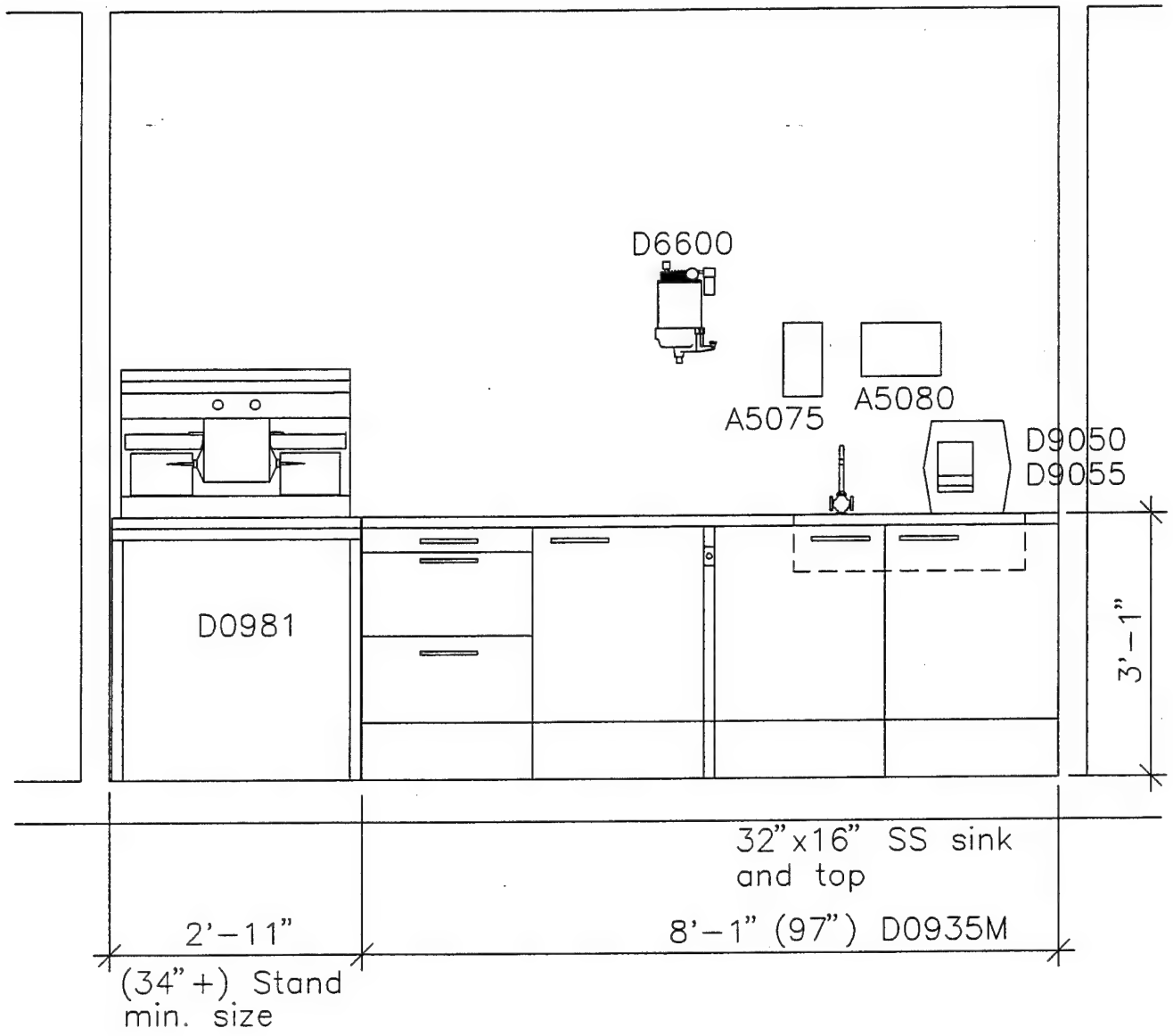
JSN	Description
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
D0910	WORKSTATION, DENT LAB, METAL GRINDING
D0935	WORKSTATION, DENT LAB,INVEST,97WX24DX37H
D0941	WORKSTATION, LAB, EQUIPT BENCH MODIFIED
D0981	WORKSTATION, POLISHING BOX, ON SS STAND
D3295	CHAIR, ROTARY, LABORATORY, DENTAL
D6600	MIXER/INVESTOR, VACUUM, 2SP, 1/3HP
D8950	VIBRATOR, MOLDING, DENTAL
D9050	TRIMMER, MODEL, DENTAL, 1/4HP, 13x13x16
D9055	VALVE, TRIMMER, MODEL, DENTAL
D9056	VALVE, AIR, NEEDLE CONTROL
D9057	VALVE, GAS, NEEDLE CONTROL
F2000	BASKET, WASTEPAPER, ROUND,METAL,18X16DIA
M6605	SHELVING, METAL, 2 LEVEL, 12" DEEP
P1960	STATION, WASH, EYE/FACE, COUNTER TOP



Ortho Lab Elevation – Left Side

Scale: 1/2" = 1' – 0"

DWG NO. 38



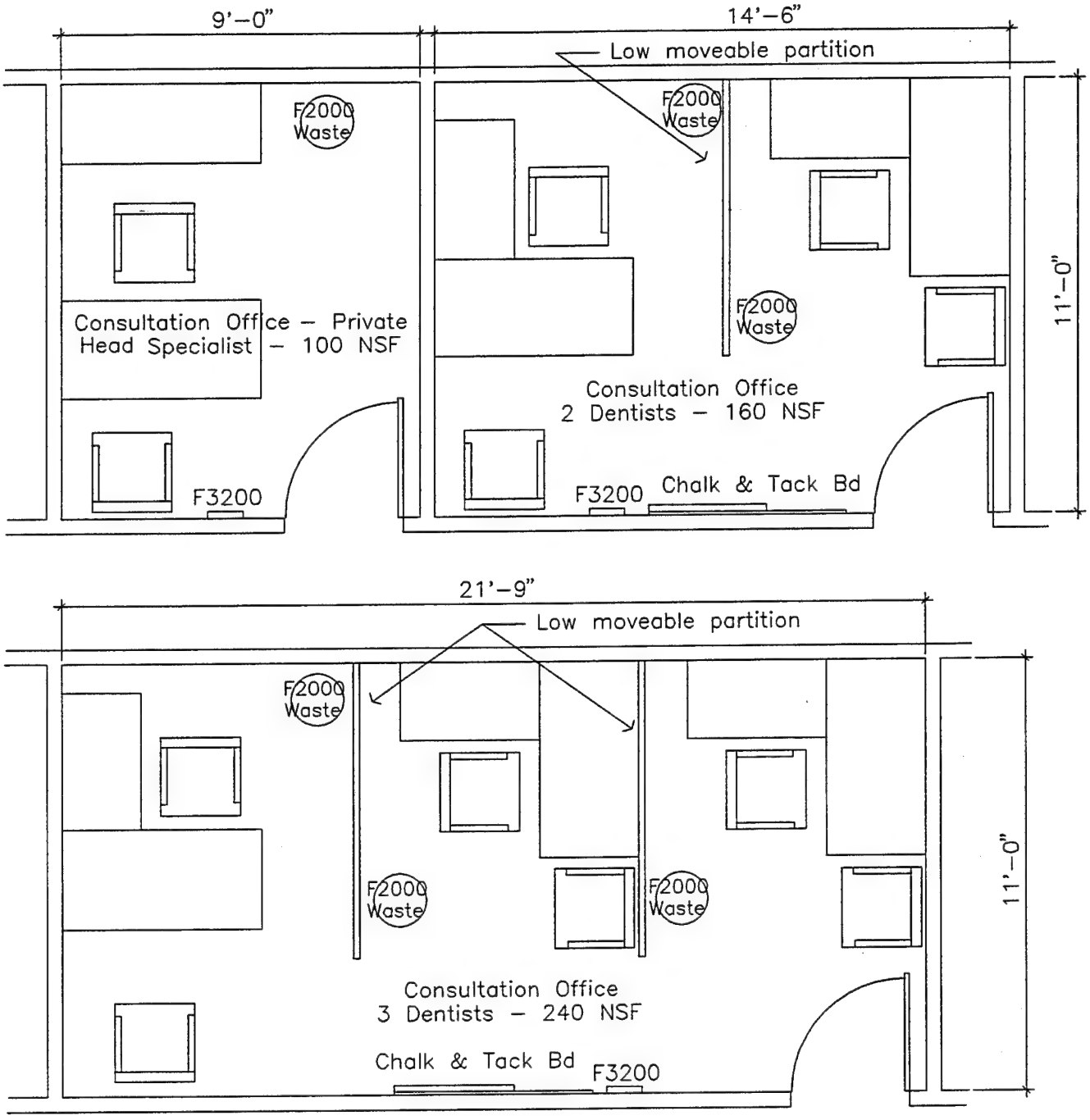
Ortho Lab Elevation - Right Side

Scale: 1/2" = 1' - 0"

DWG NO. 39

Part X

Standard Consultation Offices



Standard Consultation Offices

Scale: 1/4" = 1'–0"

Note: Minimum private office size 100 NSF. Multiple offices 80 NSF per Dentist

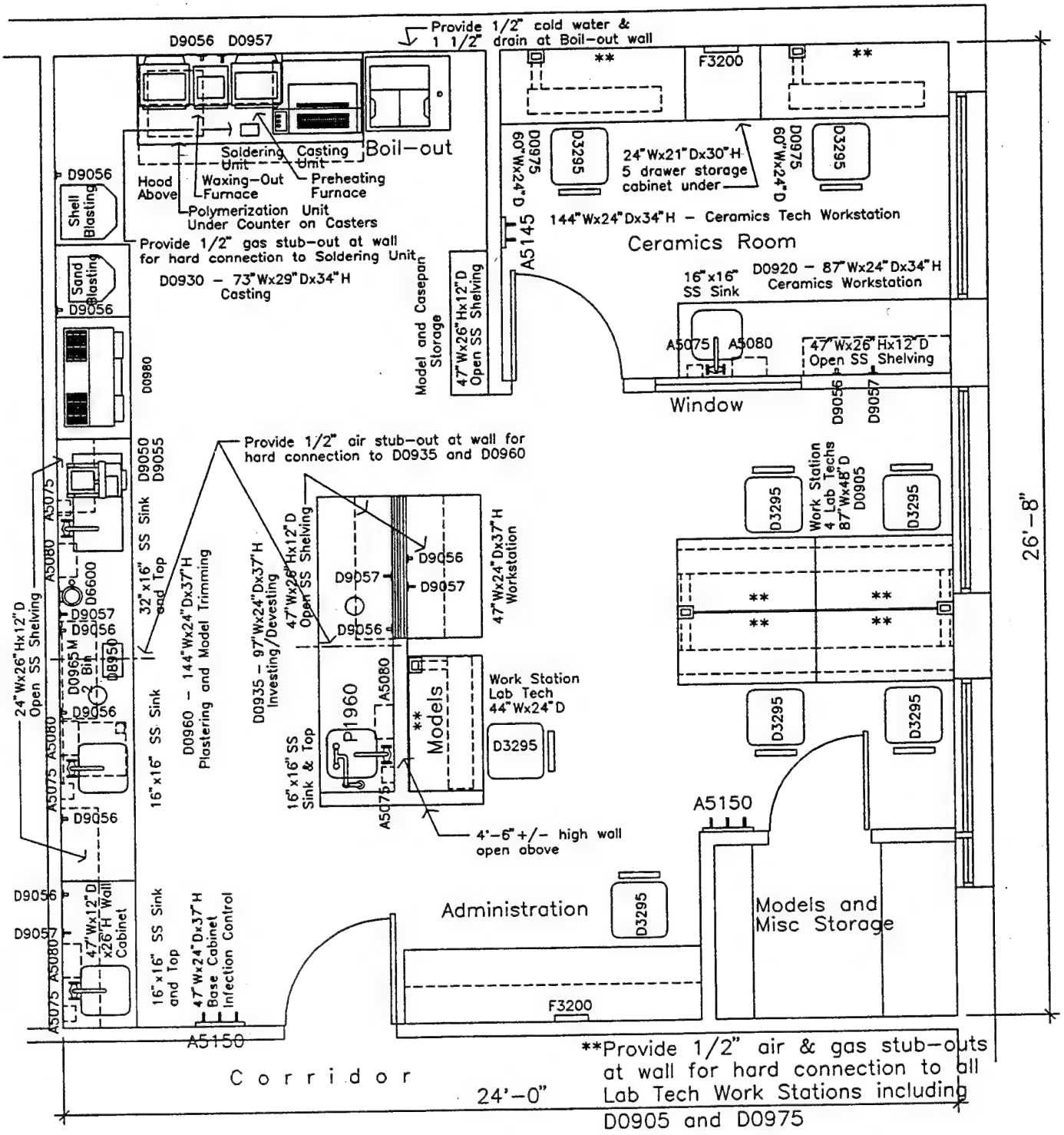
MIL–HDBK–1191 Room Code, OFA01

DWG NO. 39a

Part XI

Prosthodontics and Ceramics Laboratory

Four - Technician



Prosthodontics and Ceramics Laboratory Floor Plan - Four Technicians

Scale: 1/4" = 1'-0"

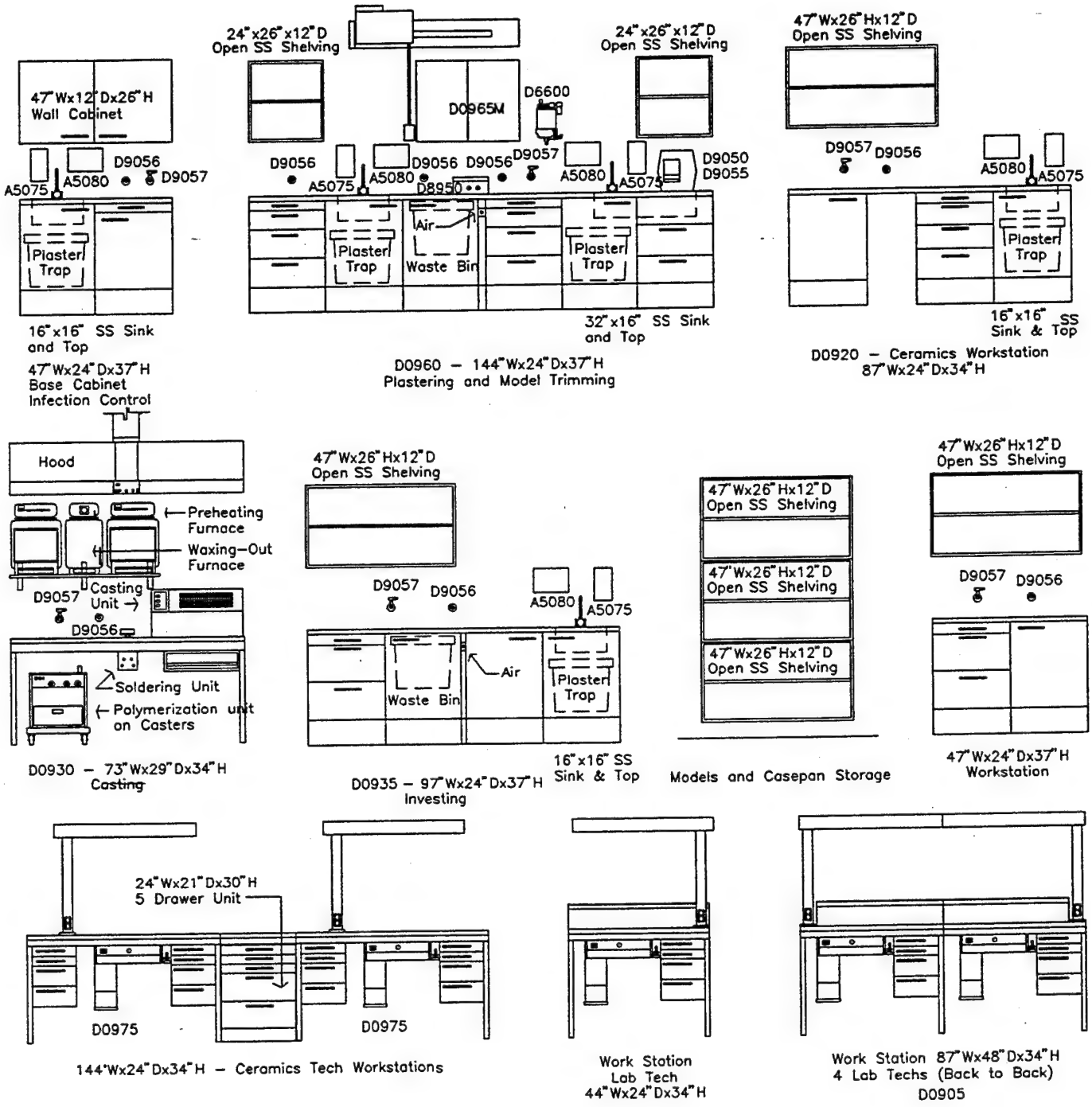
Note: Laboratory space size shown is based on DOD Medical Space Planning Criteria for Dental Clinics. Space allowed: 450SF (4 Technician Lab) + 120SF (2 Ceramics Lab Technicians Min.) + 70SF (Model Storage) = 640SF Total NSF

MIL-HDBK-1191 Room Code, DNPF1

DWG NO. 40

Prosthodontics and Ceramics Laboratory - 4 Technicians Equipment List

JSN	Description
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
A5150	HOOK, ROBE, 3 PRONG
D0905	WORKSTATION, DENT LAB, 4 TECHNICIAN
D0920	WORKSTATION, DENT LAB, FLOOR STANDING
D0930	WORKSTATION,DEN LAB,CASTING, 73WX29DX34H
D0935	WORKSTATION, DENT LAB,INVEST,97WX24DX37H
D0960	WORKSTATION, DENT LAB, PLASTER
D0965	DISPENSING SYSTEM, DENT LAB, WALL MOUNT
D0975	WORKSTATION, DENT LAB, DIE TRIMMING
D0980	WORKSTATION, DENT LAB, POLISHING, SINGLE
D3295	CHAIR, ROTARY, LABORATORY, DENTAL
D6600	MIXER/INVESTOR, VACUUM, 2SP, 1/3HP
D8950	VIBRATOR, MOLDING, DENTAL
D9040	TRIMMER, MODEL, DENTAL, 1/2 HP
D9050	TRIMMER, MODEL, DENTAL, 1/4HP, 13x13x16
D9055	VALVE, TRIMMER, MODEL, DENTAL
D9056	VALVE, AIR, NEEDLE CONTROL
D9057	VALVE, GAS, NEEDLE CONTROL
F3200	CLOCK, BATTERY, 12 DIA



Prosthodontics and Ceramics Laboratory Equipment Elevations – 4 Technicians

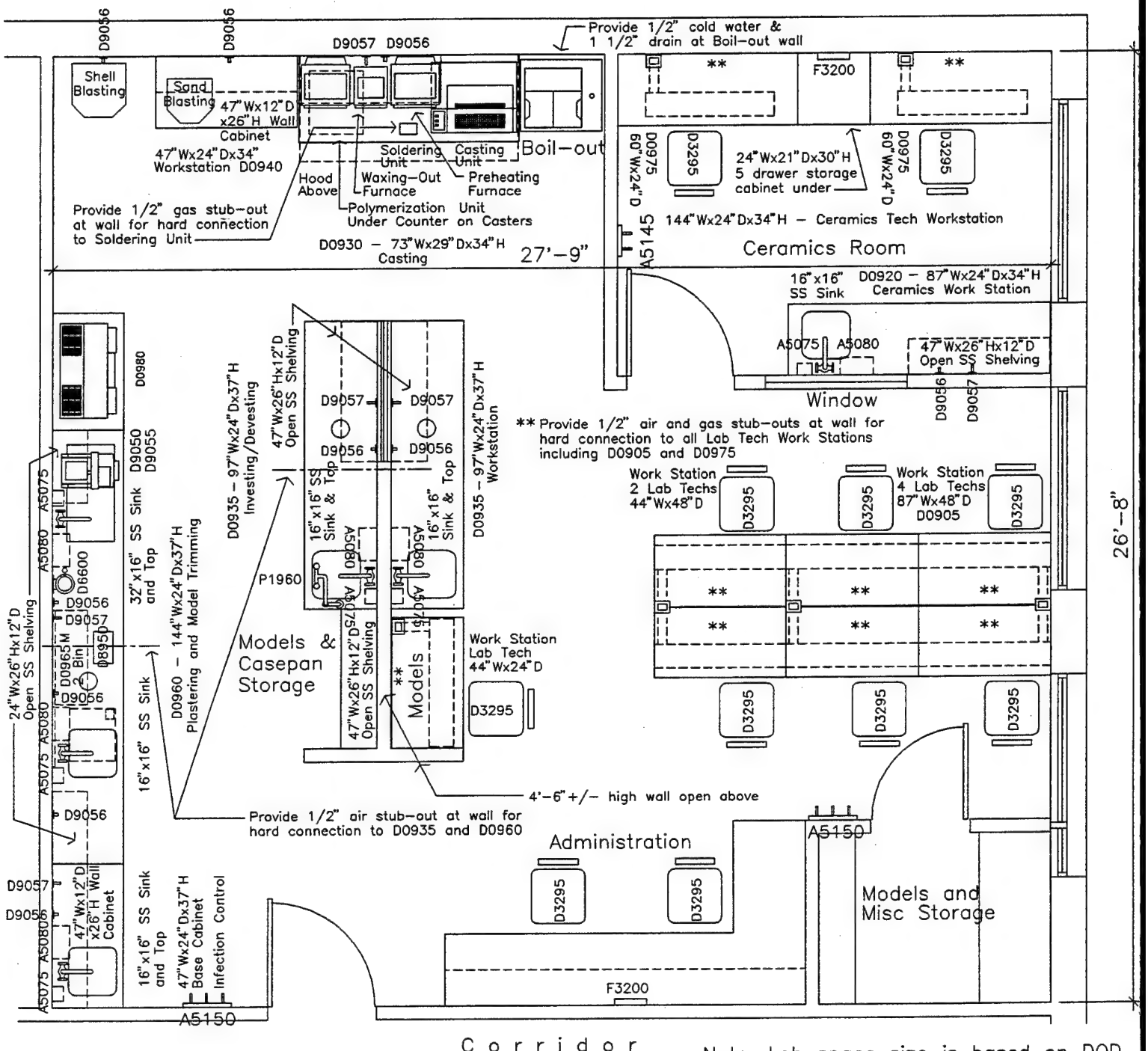
Scale: 1/4" = 1'–0"

DWG NO. 41

Part XII

Prosthodontics and Ceramics Laboratory

Six -Technician



Prosthodontics and Ceramics Lab Floor Plan — Six Technicians

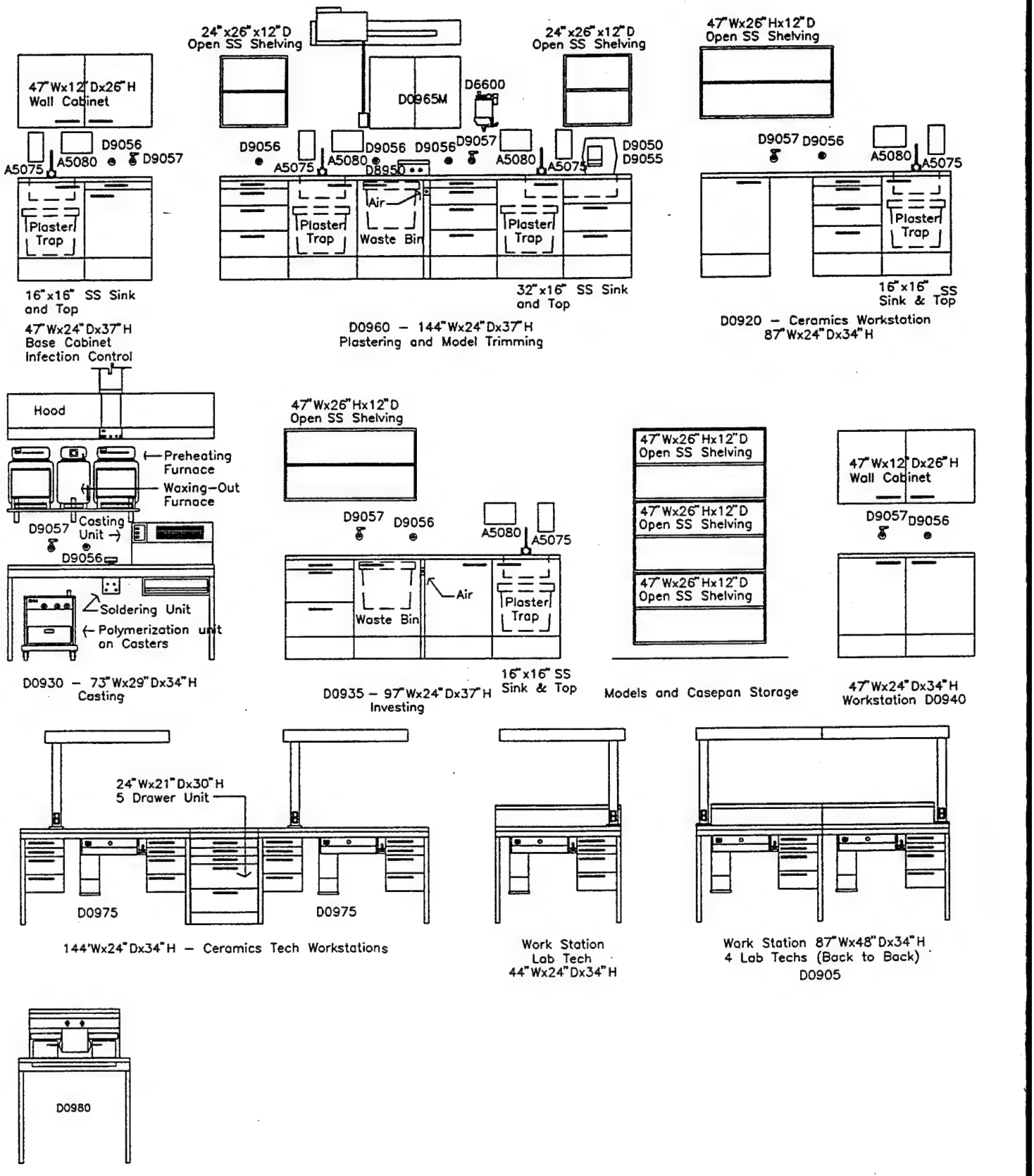
Scale: 1/4" = 1'-0"

Note: Lab space size is based on DOD Medical Space Planning Criteria for Dental Clinics. Space allowed: 550SF + 120SF (2 Ceramics Techs Min.) + 70SF (Model Storage) = 740 NSF total

DWG NO. 42

Prosthodontics and Ceramics Laboratory - 6 Technicians Equipment List

JSN	Description
A5075	DISPENSER, SOAP, DISPOSABLE
A5080	DISPENSER, PAPER TOWEL, WALL MOUNTED
A5145	HOOK, ROBE, 2 PRONG
A5150	HOOK, ROBE, 3 PRONG
D0905	WORKSTATION, DENT LAB, 4 TECHNICIAN
D0920	WORKSTATION, DENT LAB, FLOOR STANDING
D0930	WORKSTATION,DEN LAB,CASTING, 73WX29DX34H
D0935	WORKSTATION, DENT LAB,INVEST,97WX24DX37H
D0940	WORKSTATION, DENT LAB, EQUIPMENT BENCH
D0960	WORKSTATION, DENT LAB, PLASTER
D0965	DISPENSING SYSTEM, DENT LAB, WALL MOUNT
D0975	WORKSTATION, DENT LAB, DIE TRIMMING
D0980	WORKSTATION, DENT LAB, POLISHING, SINGLE
D3295	CHAIR, ROTARY, LABORATORY, DENTAL
D6600	MIXER/INVESTOR, VACUUM, 2SP, 1/3HP
D8950	VIBRATOR, MOLDING, DENTAL
D9040	TRIMMER, MODEL, DENTAL, 1/2 HP
D9050	TRIMMER, MODEL, DENTAL, 1/4HP, 13x13x16
D9055	VALVE, TRIMMER, MODEL, DENTAL
D9056	VALVE, AIR, NEEDLE CONTROL
D9057	VALVE, GAS, NEEDLE CONTROL
F3200	CLOCK, BATTERY, 12 DIA



Prosthodontics and Ceramics Laboratory Equipment Elevations – Six Technicians

Scale: 1/4" = 1'–0"

DWG NO. 43

Part XIII

Prosthodontics and Ceramics
Laboratory Utilities Criteria

Utilities, general: The four and six-technician laboratory examples shown herein reflect the major plumbing outlet approximate location requirements; however, accurate locations are not shown. In the design development stage, it shall be the designers responsibility to work with the User, equipment manufacturer, and the Dental Investigation Service (DIS), to ascertain the more accurate utility dimensional locations, both horizontally and vertically. This information shall be reflected on the contract plans showing the locations of all utilities inclusive of electrical as well as plumbing outlets.

1. Electrical outlets are not shown on drawings. As a general rule, provide duplex 115V convenience outlets horizontally at 3 foot+/- on center above counter top splashes. For special or specific electrical outlet connections, vertical and horizontal locations, ampere and voltage requirements, and dedicated circuits, work with the User, equipment manufacturer, and the Dental Investigation Service (DIS) to provide this information on the contract plans.

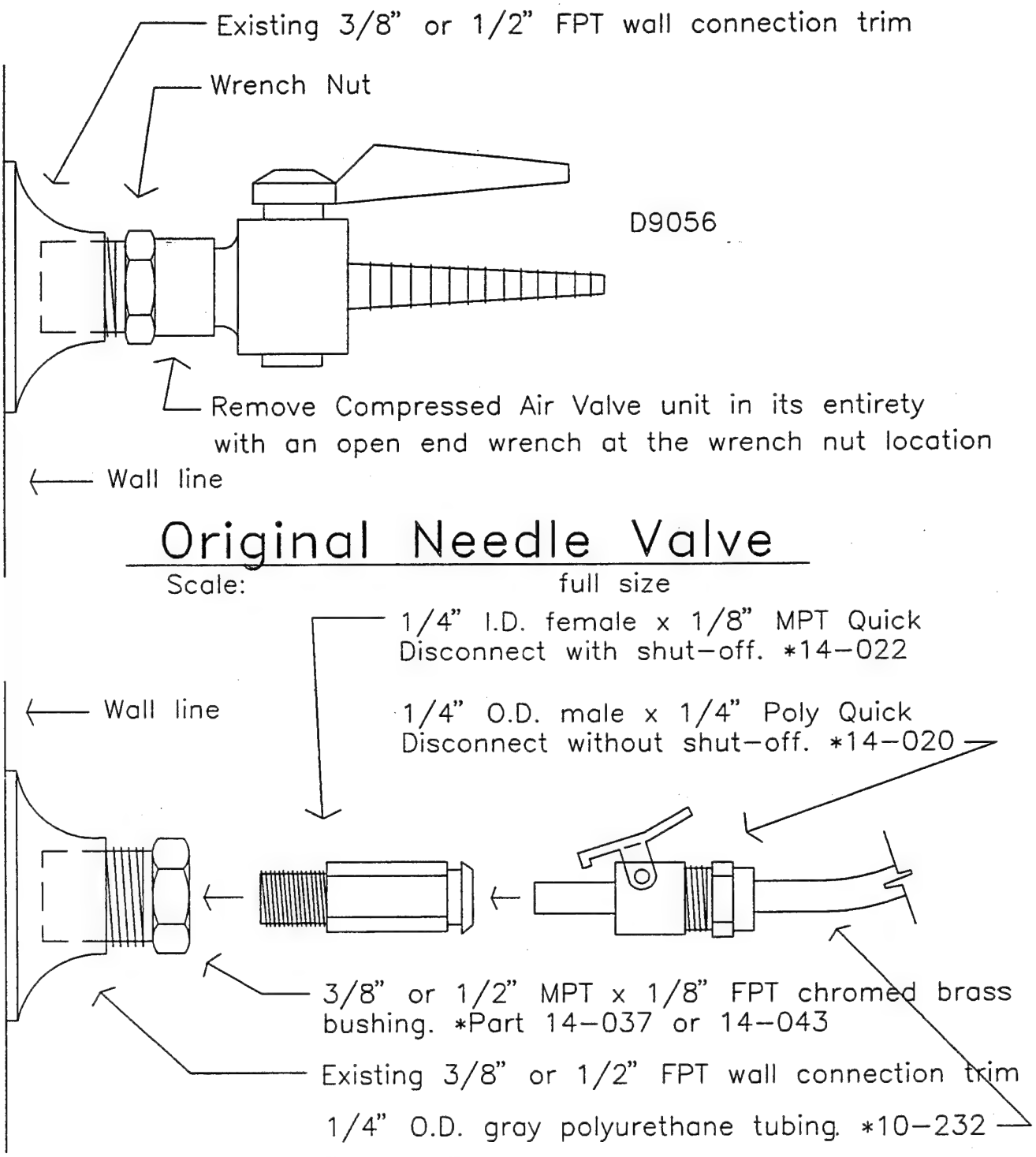
2. Where sinks are shown, hot and cold water with a drain is required. Where an eyewash is shown at a sink, **do not** provide a cold water cut-off in the cabinet below, as is required by OSHA. Therefore, the water line serving the eyewash shall not have cut-off valve accessibility within the laboratory room area.

3. In general, air needle valve D9056 is shown at all required dental air (DA) 90PSI outlet locations; however, DIS recommends replacing this valve in the design stage of all projects with quick disconnect outlets (similar to attached cut sheets of recommended connectors for DIPCs and DTR Support Rooms. See DWG NO. 44 and 45.), spaced horizontally at 3 foot+/- on center above counter top splashes. Consult with DIS and User to decide upon types and sizes of connectors that are preferred to replace needle valves. Other DA locations are shown on attached example laboratory drawings. Except at hard connections, all other DA outlets shall have quick disconnect connections.

4. As a general rule, provide at least one D9057 gas needle valve above each counter top at Plastering/Models, Investing/Devesting, Work Station counter tops (other than Lab Tech individual work stations), Ceramics Work Stations etc. and at other specific locations as requested by the User.

Part XIV

Recommended 90 PSI Air Connection for Sterilization Areas



Original Needle Valve

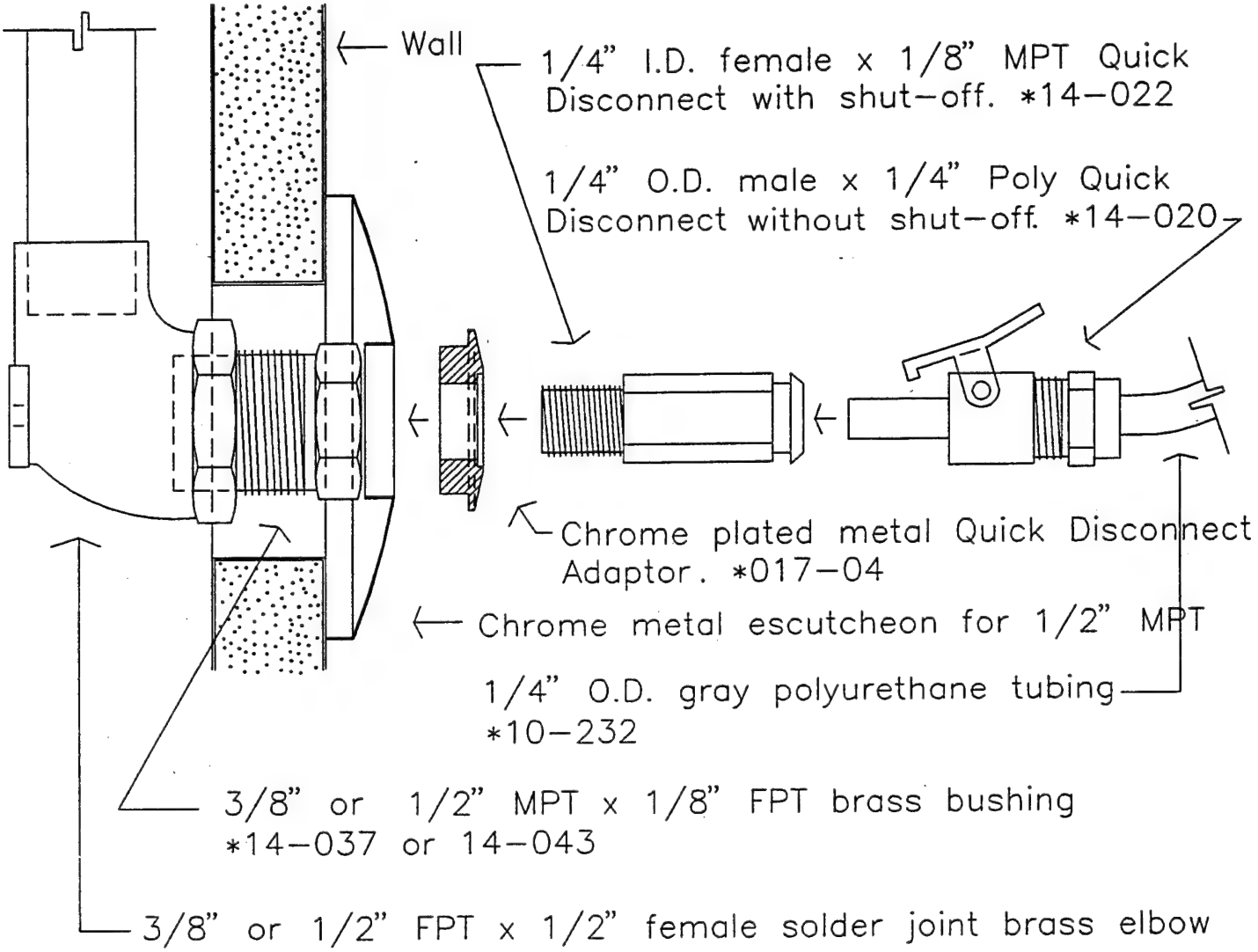
Scale: full size

Recommended 90 PSI Air Connection at Existing Air Outlets in Sterilization Areas

Scale: Full Size

*Numbers shown are part numbers as manufactured and supplied by Chapman-Huffman Company, 320 S.E. Bridgeford Blvd., Suite 1, Bend, Oregon 97702, Ph. (541) 382-7869

DWG NO. 44



*Numbers shown are part numbers as manufactured and supplied by Chapman-Huffman Company, 320 S.E. Bridgeford Blvd., Suite 1, Bend, Oregon 97702, Ph. (541) 382-7869

Recommended 90 PSI Air Connection at New Air Outlets in Sterilization areas

Scale: full size

DWG NO. 45

Part XV

Dental Systems Guide Specifications

Section A. Central Dental High-Volume Oral Evacuation (HVE) Systems
Section B. Central Dental High-Vacuum (HIVAC) Oral Evacuation systems
Section C. Central Dental Surgical Handpiece Drive Air (SHDA) Systems
Section D. Dental Compressed Air (DCA) Systems

Part XV

Section A

Central Dental High-Volume Oral Evacuation (HVE) Systems

1. INTRODUCTION

1.1 Dental High-Volume Oral Evacuation System. The dental high-volume oral evacuation (HVE) system is an independent clinical vacuum system specifically designed for scavenging, collection, and disposal of liquids, solids, and aerosols from the patient's mouth. Control of aerosols generated by the high-speed air turbine handpiece and emanating from the operating site is essential to prevent contamination of breathing zones and the treatment environment in general. Equally important for safe and effective treatment delivery is the ability of the HVE to maintain a clear visual pathway and operating site during operating procedures.

1.2 Application. The HVE system described and specified herein applies to composite or free-standing USAF dental facilities containing more than six dental treatment rooms (DTRs).

1.3 Components. The HVE system consists primarily of the following components:

- Two remote-controlled and monitored vacuum turbines (turboexhausters) with individual noise, flow, and vacuum controls.
- One or two central separator/collector tank(s) equipped with overflow protectors, flow and drain controls, self-cleaning capability, and a connection to sewer.

1.4 Delivery. HVE service is distributed to designated utility centers in all DTRs in the dental facility by a specially sized and equipped centrally piped distribution network for wet line operation.

1.5 Performance. The system and the distribution network are designed so that all inlets function in a specified, consistent performance range.

1.6 End Items. Clinical end items (suction tips, hand valves, hoses, and solids collectors) are considered part of the DTR delivery system, and are not included in this report.

1.7 Guidelines. The guidelines provided in this document are minimum requirements for safe, proficient, reliable, and cost-effective HVE systems. The information provided is applicable to all HVE systems in new construction and in system replacement projects. The information is intended to supplement and provide a basis for other design criteria, guide specifications, codes and specifically MIL-HDBK-1191, DOD Medical and Dental Treatment Facilities Design and Construction Guide.

1.8 System and Distribution Network. The HVE system and associated distribution network are not used in flammable gas locations, are not used to scavenge flammable anesthetic

gas, and are not installed in inpatient treatment areas. Therefore, the system and distribution network are not within the jurisdiction of National Fire Protection Association (NFPA) Standard 99.

2. DEFINITIONS

2.1 Air Flow. Air-flow references are in standard cubic feet per minute (SCFM).

2.2 Antisurge Valve. A mechanically controlled in-line air bleed valve designed to sense and compensate for change in system vacuum pressure.

2.3 Backward Curve Impellers. Turboexhauster impellers whose vanes are arched across the impeller radius so that the convex curve faces the direction of rotation to enhance turboexhauster efficiency and performance.

2.4 Central Separator/Collector Tank. A negative pressure vessel designed for cyclonic separation of air from liquid and solid HVE effluent, designed, sized, and equipped as specified.

2.5 Directional Flow Valve. An in-line swinging gate valve used for unidirectional flow control.

2.6 Centrally Piped Distribution Network. The central plumbing for distribution of HVE service throughout the dental facility, designed, sized, and equipped as specified; beginning with the riser input terminal fittings in specified locations; and terminating at the point of connection to the HVE system central separator/collector tank(s).

2.7 High-volume Oral Evacuation System. The assembly of components for the specified production of clinical dental oral vacuum service and for effluent disposal; consisting of two multistage vacuum turbines, central separator/collector tank(s) and all electrical, mechanical, fluidic and noise controls, components and interconnections specified and/or required; designed and sized as specified for continuous duty; and terminating at the point of connection to the HVE centrally piped distribution network.

2.8 Input Terminal. Specified riser end fittings.

2.9 Internal Washdown System. An automatic, serviceable, cold water rinsing system with spray head located in the top of the HVE separator/collector tank(s) to enhance sanitation and prevent sludge buildup.

2.10 Isolation Pads. Blocks or pads of resilient material used to support equipment frames or bases to prevent transmission of equipment vibration to the structural parts of the facility.

2.11 Liquid Level Sensor. (Primary tank overflow guard) A system of electrodes (detectors) installed in the HVE separator/collector tank(s) at locations to detect the effluent levels within the tank(s) at high and low points. When immersed in effluent, the electrode conducts an electrical current to operate a relay device which either starts a pump or actuates a solenoid valve to effect tank drainage.

2.12 Manifold. The downstream end of the HVE centrally piped distribution network consisting of a nominally sized pipe which connects the trunk lines to the system separator/collector tank(s).

2.13 Pipe Isolators. Flexible, resilient, band-clamped sleeves used for plumbed connections to equipment to prevent transmission of equipment vibration to connected pipes and components.

2.14 Riser. The upstream end of the HVE centrally piped distribution network consisting of a 3/4 inch nominally sized pipe which connects the riser input terminal fitting to the HVE trunk line.

2.15 Safety Float. (Secondary tank overflow guard) A caged float valve located in the HVE separator/collector tank such that a high liquid (effluent) level caused the float to close the tank exhaust air output to prevent further effluent input and subsequent turboexhauster damage.

2.16 Silencer. An in-line device to provide abatement of air-generated noise without line restriction an back pressure.

2.17 Solenoid Valve. An electrically operated in-line valve.

2.18 Trunk Lines. The nominal pipe size branch lines of the HVE centrally piped distribution network which connect the risers to the manifold.

2.19 Turboexhauster. A multistage, direct drive, vacuum-producing turbine designed, sized, and equipped as specified, used to power the HVE system.

2.20 Vacuum Pressure. Vacuum pressure references are in inches of mercury (in. Hg).

2.21 Volume Control Valve. An adjustable, in-line, minimum restriction valve for air flow control.

2.22 Wet-Line Operation. Piped transport of a combination of air, liquids and solids.

3. REQUIREMENTS

3.1 Equipment Design. The HVE system and HVE central distribution network are designed to support the requirements for general dental oral evacuation and, except for the use of HVE vacuum producers to power the central janitorial vacuum system as specified elsewhere, shall not be used for any other purpose.

3.2 System Devices. The HVE system and central distribution network shall consist of standard manufactured products, complete with all devices normally furnished and devices required herein. When devices normally furnished conflict with devices required herein, the devices required herein shall have precedence. The HVE system shall be supplied by a manufacturer regularly engaged in the manufacture of commercially available, industrial-quality central vacuum systems for at least two years prior to bid opening. The manufacturer shall supply a complete system assembly and shall serve as a single source for spare parts and service for all components in the system regardless of original vendor.

3.3 Installation. The HVE system shall be installed in a well-ventilated mechanical space within the served facility or in a separate mechanical space structure within 20 ft. of the served facility.

3.4 Performance. Individual DTR HVE performance, measured with one inlet operating in not less than 70% of the total facility DTRs simultaneously, shall be within the following ranges:

Volume: 12-15 standard cubic feet per minute (scfm)

Vacuum: 7-8 inches of mercury (in. Hg)

3.6 Performance Measure. Performance shall be measured by the specified test procedures.

3.7 HVE System.

3.7.1 The HVE system shall include, but not be limited to, the following major components:

- Central separator/collector tank(s)
- Mechanical and electrical tank overflow protectors
- Internal tank washdown system
- Air control solenoid valves or high pressure in-line waste pumps
- Turboexhausters
- Silencers
- Volume control valves
- Antisurge valves
- Directional flow valves

- Isolation pads
- Plumbing isolators
- Electrical controls and enclosures
- Remote Control Panel

3.7.2 Separator/collector tank(s).

3.7.2.1 The HVE system shall contain one or two separator/collector tank(s) of specified capacity according to facility size (number of DTRs) as follows:

	Separator Tanks	
No. of DTRs	Quantity	Size (gal)
1 - 6	1	20
7 - 10	1	40
11 - 20	1	80
21 - 30	2	40
31 and above	2	80

3.7.2.2 Tank(s) shall be high negative pressure vessels certified by the system supplier to withstand a constant negative pressure of not less than 20 in. Hg. Tanks shall be constructed of nonmetallic, inert, reinforced plastic or hot-dipped galvanized steel. Tank bottoms shall be convex with a drain connection located at the apex of convexity to enhance discharge of all contents. Tank inlets shall be tangential to the tank body to effect cyclonic separation of air from effluent.

3.7.2.3 Tank(s) shall be equipped with a timer-controlled, internal, cold water washdown system, adjustable for frequency and duration of washdown. The system shall include a cold water supply filter with 40-mesh stainless steel screens (located to protect the solenoid valve), a water supply solenoid valve, a 360° spray nozzle, and a 115-VAC clock control mechanism. The clock shall control the solenoid to effect frequency (once each 24 hr. interval) and duration (not more than 3 min.) of washdown. The clock shall have skip-interval capability to eliminate washdown during weekends.

3.7.2.4 Each tank shall be equipped with a primary overflow protection system consisting of electronic high- and low-liquid-level sensors, power supply, and a 115-VAC electrically operated tank output air-solenoid valve. The solenoid valve shall be located to control the output air from tank to turboexhauster and shall be switched by the sensors. In multiple-tank installations, one tank shall be adjusted to sense 90% of its capacity, and the other tank 100% of its capacity by the liquid-level sensing devices. This procedure shall allow for nonsimultaneous discharging and, therefore, uninterrupted HVE function to the facility.

3.7.2.5 Each tank shall be equipped with a secondary overflow protection device consisting of a caged, mechanical safety float positioned to close the tank output air orifice in the event of high-liquid-level sensor failure.

3.7.2.6 Each tank shall be equipped with a gate- or swing-type directional flow valve at the bottom drain. With negative pressure in the tank (systems operating), the check valve shall remain closed to maintain vacuum. When negative pressure ceases, either by exhauster shutdown or closure of the outgoing air-solenoid control by the liquid -level sensor, the check valve shall open and the tank shall undergo gravity drainage to sewer.

3.7.2.7 In any HVE installation, where a floor sink cannot be made available for separator tank drainage, and effluent must be moved overhead to sewage input, high-pressure pumps shall be the option of choice. One pump per separator tank shall be installed. Pumps shall be high-pressure in-line types connected between the separator tank drain outlet and the sewer inlet. The gate- or swing-type valve normally installed at the tank drain outlet shall be relocated downstream of the pump output side to assure pump priming and preclude pump impeller damage from dry initial startup. Pumps shall be capable of sufficient power as to accomplish draining of the separator tank against vacuum produced by the turbine. When high-pressure pumps are used, the output air-solenoid valve between the separator tank air outlet and the turboexhauster input shall not be used. Power to the high-pressure and in-line pumps shall be controlled by the liquid level sensors in the separator tanks.

3.7.2.8 All interconnecting piping between multiple tanks and between tank(s) and turboexhausters shall be acrylonitrile butyl styrene (ABS) or polyvinyl chloride (PVC), conforming to Schedule 40 or Class 200 specifications.

3.7.3 Turboexhausters.

3.7.3.1 The HVE system shall contain two turboexhausters connected in parallel.

3.7.3.2 Each turboexhauster shall have a minimum capability to produce the specified individual DTR HVE performance in 70% of the total number of facility DTRs, to include the DTRs most distant from the vacuum source.

3.7.3.3 Line losses caused by the HVE centrally piped distribution network shall be compensated by adjustment of turboexhauster capability.

3.7.3.4 Power to operate the turboexhaust shall be in direct proportion to the volume of air exhausted and shall not exceed the normal motor rating.

3.7.3.5 Horsepower rating for the turboexhauster drive motor shall not exceed the following quantities for capacities and pressures shown:

	7	8	9	10	11	12
H.P.	SCFM					
5	90	64				
7 1/2	180	165	100			
10	240	220	185	150		
15	375	350	275	200	125	100
20	560	475	400	300	260	225
25	770	600	475	400	335	300
30	840	725	625	540	430	360
40	1225	1000	825	650	565	480
50	1530	1250	1100	900	725	600

3.7.3.6 Vacuum Produced shall be substantially constant throughout the operating volume range of the turboexhauster regardless of the number of using DTRs (one inlet used per DTR) below the maximum design capacity of the turboexhauster.

3.7.3.7 The turboexhauster shall produce its certified volume and vacuum at the above-sea-level altitude of the installation site; shall be tested and measured by the manufacturer prior to delivery, and shall be performance certified (capacity and vacuum) as indicated by an equipment plate permanently attached to the turboexhauster.

3.7.3.8 Turboexhausters shall be self-governing, multistage, centrifugal type, of outboard design (bearings on both ends of the exhauster shaft). The turboexhauster shall operate at a speed not to exceed 3600 rpm and shall be connected to its driving motor by a flexible coupling (no belts, pulleys, or gears). A steel coupling guard encompassing the flexible coupling shall be installed between the motor and turboexhauster. Bearings may be sealed or the lubricant type. To reduce bearing lubricant temperature, a fan shall be connected directly to the exhauster shaft adjacent to exhauster shaft bearings to create a flow of ambient air over the bearing carrier while the unit is operating.

3.7.3.9 Turboexhauster cases and end plates (inlet and exhaust heads included) shall be constructed of either heavy-gauge sheet steel rigidly welded at all seams and sections, or of cast gray iron. Sheet steel end plates shall be either concave or convex for flex resistance. Inlet and exhaust connections shall be tangential to the exhauster case and sized to allow free air movement through the exhauster, without flow restriction.

3.7.3.10 Internal moving parts of the turboexhauster shall be constructed with not less than 0.125 inch clearance throughout to prevent damage by transient particulates. Impellers shall be constructed of built-up sheet metal, smooth on all surfaces to prevent imbalance by uneven dust deposits. Impellers shall be of the backward curved design to provide optimal performance over a wide range of volume requirements. Impellers shall be securely attached to the exhauster shaft by setscrews or clamps of high-tensile material. Each impeller shall be individually balanced. The complete assembly, with motor, shall not exceed 1.5 millimeters of vibration when given a running test.

3.7.3.11 Each turboexhauster and its drive motor shall be separately mounted to a common frame of welded steel as an assembly.

3.7.3.12 The drive motor for the turboexhauster shall be a standard National Electrical Manufacturers Association (NEMA) 3500 rpm, T-frame, open drip-proof design; rated 200, 230, 460 VAC, 60 Hz, three-phase; with seal- or lubricant-type bearings. Operational temperature rise of the motor shall not exceed 40° C (104° F). All motors shall be high efficiency types, as classified by NEMA criteria, and shall be rated for continuous duty.

3.7.3.13 The input of each turboexhauster shall have an adjustable air-volume control valve to prevent accidental motor overload and to provide a means of adjusting the upper design capacity limit. The volume-control valve shall be built in or immediately adjacent to the first or input stage of the turboexhauster, and shall be preset by the manufacturer during certification procedures. The volume-control valve shall be a butterfly-type to minimize air turbulence.

3.7.3.14 The input of each turboexhauster shall have a mechanical-type antisurge valve that shall operate proportionally and automatically throughout the exhauster's design range. This valve shall continually sense the negative pressure within the input line or exhauster and maintain the specified level of negative pressure by proportionally bleeding air into the system. The valve shall be equipped with a silencer to attenuate air noise to 85 decibel average (dBA) or less. The valve shall be installed in, on, or near the first stage of the turboexhauster or shall be mounted in conjunction with the directional flow valve.

3.7.3.15 The input of each turboexhauster shall have a directional flow valve to prevent backflow of air though the idle turboexhauster of the pair. Directional flow valves shall be gate or swing types for fast, positive response.

3.7.3.16 No manual valves shall be permitted in the system interconnecting air handling plumbing or in the system exhaust ducting.

3.7.3.17 Each turboexhauster/motor assembly frame shall be mounted on resilient isolator pads which shall be furnished by the system manufacturer. The pads shall not be fastened to the facility floor. Vibration transmission shall be limited to less than 5% of the lowest frequency of vibration.

3.7.3.18 Pipe isolators shall be furnished by the system manufacturer and shall be used for all plumbing and system component interconnections to the turboexhauster inlets and outlets for control of vibration transfer.

3.7.3.19 Each turboexhauster output shall be provided with an air-discharge silencer of the open bore expansion type. No interior baffling shall be permitted. The silencer shall attenuate exhaust air noise to a level below 85 dBA.

3.7.3.20 Exhaust extension to the facility exterior shall be through metal ducting with no bends or turns.

3.7.4 Electrical Controls.

3.7.4.1 The electrical system shall be installed in accordance with the latest edition of the National Electric Code and/or local regulations.

3.7.4.2 Each turboexhauster shall be equipped with individual electrical controls and enclosures, each to include a combination across-the-line magnetic starter with time-delay fused disconnects; a running hour meter; a two-button start-stop switch; and a warning light and audible alarm to indicate shutdown due to fuse failure.

3.7.4.3 Electrical controls shall include a complete low-voltage control function with labeled remote control panel for remote operation and monitoring of the turboexhausters.

3.7.4.4. The labeled low-voltage remote control panel shall be a dual design containing a separate on-off switch for manual switching of either or both turboexhauster(s); pilot lights to indicate operation; and a certified vacuum gage (graduated in. Hg) to monitor vacuum pressure in the system.

3.7.4.5 The labeled remote control panel shall be located in the administration/records/reception area of the dental clinic.

3.8 Centrally Piped Distribution Network.

3.8.1 Piping and fittings shall be ABS or PVC, conforming to schedule 40 or class 200 specifications.

3.8.2 All fittings shall be long-radius bend types for turns and wye types for branching. For small bore piping for which long-radius bends are not available, two 45° bends shall be substituted for 90° turning.

3.8.3 All horizontally installed pipe shall slope (fall) not less than 0.120 in./ft. toward the vacuum source.

3.8.4 All risers to all HVE inlet locations shall be 0.75 inch nominal pipe size. Risers shall connect to trunk lines whose nominal pipe sizes shall be determined by internal cross-sectional area required.

3.8.5 The cross-sectional area of all trunk lines shall be graduated, increasing toward the vacuum source. The cross-sectional areas at any point along the trunk line shall equate to the sum of the riser cross-sectional areas connected prior to that point. Individual trunk lines shall terminate with connection to the manifold of the separator/collector tank(s).

3.8.6 An adjustable, mechanical, vacuum relief valve shall be installed at the upstream terminus of each trunk line so that all riser connections to the trunk line are between the vacuum relief valve and the manifold. The vacuum relief valve shall be adjusted to bleed air into the trunk line when all inputs to that trunk line are turned off. The air volume relief valve shall be equipped with a silencer to attenuate air noise to 85 dBA or less.

3.8.7 The HVE inlet locations and riser terminal configurations shall be provided as follows:

3.8.7.1 Dental treatment rooms:

3.8.7.1.1 One inlet in each wall-mounted utility center and floor utility center when assistant's instrumentation is chair-mounted. The terminal configuration of the 3/4 inch riser shall be a 1.5 inch exposed length of 0.150 inch nominal copper pipe for clamp connection of clinical equipment hose.

3.8.7.1.2 In wall-mounted utility centers which serve two adjacent DTRs, two inlets shall be provided by branching the riser into two terminal configurations as above.

3.8.7.2 Sterilizer rooms/alcoves and central sterilizing rooms:

3.8.7.2.1 One inlet for each chemical sterilizer installed. Terminal Configuration shall be a surface wall-mounted manual needle valve with 3/8 inch O.D. hose barb inlet.

3.8.7.2.2 Inlet valves shall be located on wall, 4 inch above counter backsplash, at each chemical sterilizer location.

3.8.7.2.3 One riser shall be branched to supply all inlets required for one room or alcove.

3.9 System Inspection, Startup and Testing.

3.9.1 The installer shall provide a factory-trained technical representative who shall inspect the system and distribution network, assist in startup and testing, and provide training to the personnel having maintenance responsibility.

3.9.2 The installer shall provide all testing materials, instruments, and equipment. Measuring instruments shall have current certification labels traceable to the National Bureau of Standards.

3.9.3 The HVE system and distribution network shall be tested for the air volume and vacuum requirements specified. Testing shall be performed after the installation inspection;

initial startup; and a 4 hr. run-in period on each turboexhauster, each operating with an air volume load equal to 70% of the facility DTRs (12 scfm/DTR) operating simultaneously. During the run-in period, the system shall be checked for overheating every hour.

3.9.3.1 The HVE retest tip assemblies shall be attached to one HVE inlet terminal/DTR; in not less than 70% of the total facility DTRs. The DTRs tested shall include those most distant and those nearest the vacuum source. All other inlets shall be closed.

3.9.3.2 The HVE test tip assemblies shall be 6 ft of nominal 0.5 inch I.D. hose with a nominal 6 inch long, 0.4375 inch I.D. metal or plastic tube (facsimile HVE suction tip). Hoses and tubes shall be suitable for transport of not less than 15 SCFM of air at 8 inch Hg vacuum pressure without collapse.

3.9.3.3 One turboexhauster shall be started and run for 30 minutes before measurements begin. After 30 minutes, each attached HVE test tip assembly shall be measured and performance shall be as specified. When all HVE test tip assembly performance is as specified, the electrical current draw of the turboexhauster drive motor shall be measured. Electrical current draw shall not exceed the motor rating.

3.9.3.4 The test shall be repeated using the second turboexhauster.

3.9.4 A general operating test shall be conducted for the system and distribution network.

3.9.4.1 Both turboexhausters shall be started and allowed to operate simultaneously for 15 min before proceeding.

3.9.4.2 Fifteen minutes after startup, one DTR inlet in each DTR in the facility shall be opened. Not less than 1 gal. of water shall be ingested by each open inlet to test general function.

3.9.4.3 Sufficient additional water shall be ingested to demonstrate the successful operation of the mechanical and electrical overfill protectors, the drainage system, and the internal tank(s) washdown system.

4. OUT-OF-CONUS INSTALLATIONS

For equipment intended specifically for installations outside of the continental United States (overseas bases), the vacuum-source drive-motor frequency and voltage requirements of this specification shall be changed to ensure compatibility with on-site electrical supply configurations. Such modifications shall not detract from equipment longevity or performance.

5. DOCUMENTATION

5.1 Instructions. The contractor shall supply tow complete sets of the manufacturer's operating and maintenance instructions as specified in paragraph 5.2 to the local maintenance organization who shall be responsible for system maintenance. Bound set covers shall be labeled with the system name, building number, contractor's name, and contract number.

5.2 General Information.

5.2.1 The manual shall include an overall description and purpose of the system or equipment. The function and purpose of each system component shall be described. The description shall include the intended use, capabilities, and limitations of the system or equipment, or systems or equipment. If the manual covers more than one model of a system or equipment, or systems or equipment modified by field change, a description of the differences shall be provided. Quick-Reference data shall be included and shall describe technical or design characteristics of the equipment. Examples of such data are:

- Descriptive (nameplate) data necessary to identify manufacturer, type, and model.
- Functional characteristics, such as: power and frequency requirement, voltage and amperage demands, outputs, and modes of operation.
- Rated outputs, such as: horsepower, cubic feet per minute (cfm), and revolutions per minute (rpm).
- Special characteristics, such as: operating temperatures, pressure, heat dissipation, and humidity.

5.2.2 A warning page, consisting of the more vital warnings extracted from those shown throughout the manual, shall be assembled and placed on the inside cover or in front of the initial page(s) of the manual (See 5.2.7).

5.2.3 Operating instructions shall include routine and emergency procedures (manual and automatic) and safety precautions. Limits to be observed in the starting, operating, stopping, or shutting down of the equipment or system shall be provided. Adequate illustrative material shall be provided to identify and locate operating controls and indicating devices. The function of each operating control and indicating device shall be included. Emergency operating instructions shall include alternate procedures to be followed when normal operation is not possible because of emergency conditions, such as power or lubricating oil failure. Emergency operating instructions and procedures shall be located fro quick and ready reference.

5.2.4 Preventive maintenance information shall be provided. Use of special tools, materials, and test equipment shall be specified, including model/type designation, as appropriate. The following procedures shall be stressed, if applicable:

5.2.4.1 Periodic cleaning and lubrication information, types of cleaning agents or lubricants required, recommended intervals, such as monthly, quarterly, semiannually, or hours of operation shall be provided. Application points and capacity (required amounts) shall be identified. Pictorial format for lubrication is desirable. Cleaning and lubrication required during repair, replacement, and reassembly shall also be covered (See 5.2.6).

5.2.4.2 Inspection. Instructions for inspection of equipment for damage and wear shall be included. Tabular or chart format is preferred and shall include, where applicable, allowable service limits, wear, backlash, end play, length and depth of scoring, and balance. These instructions shall be sufficiently complete to serve as standards by which experienced technicians may determine when parts may be continued in use and when they must be replaced.

5.2.4.3 Instructions shall be included for verification of system performance. The location of test connections and the values expected at these points shall be included, preferably in illustrated format. Data shall include a list of equipment required to accomplish the verification, such as temperature, vacuum, pressure, hydraulic, or pneumatic gages.

5.2.5 Failures that might occur during operation of equipment shall be listed. Troubleshooting data and fault isolation techniques shall state: (a) the indication or symptom of trouble, (b) the instructions necessary, including test hookups, to determine the cause, (c) special tools and equipment, and (d) methods for returning the equipment to operating conditions. Information may be given in chart or tabular format with appropriate headings.

5.2.6 Instructions shall be provided for all removal, repair, adjustment, and replacement procedures. Exploded and sectional views giving details of assemblies shall be provided, as necessary, to clarify the text. For mechanical items, dimensional information with tolerances, clearances, wear limits, maximum bolt-down torques, and in-place balancing or other means of reducing noise level, if required, shall be supplied.

5.2.7 Notes, cautions, and warnings shall be used to emphasize important and critical instructions where necessary. Notes, cautions, and warnings shall immediately precede the applicable instructions, and shall be selected as follows:

NOTE: Concerns an operating procedure or condition which should be highlighted.

CAUTION: Concerns an operating procedure or practice which, if not strictly observed, could result in damage to, or destruction of equipment.

WARNING: Concerns an operating procedure or practice which, if not strictly observed, could result in injury to personnel or loss of life.

5.2.8 Manuals shall contain all illustrations necessary to locate and identify components of operational and maintenance significance. Where necessary for clarity, illustrations shall show configuration, and the removal and disassembly of parts. The following types of diagrams shall be included: Schematic diagrams which show the arrangement of component devices or parts; wiring diagrams which show the connections of the circuit arrangement; and schematic piping diagrams which show the interconnection of components, of piping, tubing, or hose, and the direction of air flow.

5.2.9 Circuit diagrams for electronic units shall be provided to support maintenance and trouble shooting. Circuit diagrams shall cross-reference repair parts shown in test tables and parts lists. The function name of each stage or circuit, primary signal flow, test points, wave forms with pertinent characteristics, electrical characteristics of parts name of each variable control, input and output connectors/terminals, voltages, and signals shall be specified. Voltage and resistance values measured with controls set for normal operation shall be shown for significant points, such as terminal boards, and connectors. Interconnecting cable diagrams shall be furnished to show TO-FROM information, including any intermediate connections. Block diagrams shall be provided to support installation instructions, but shall not be substituted for necessary schematic diagrams.

5.2.10 Parts lists shall provide positive identification of parts necessary for support of the systems or equipment and shall include sufficient information to enable maintenance personnel to requisition replacement parts.

5.2.11 Clear and legible illustrations shall be provided to identify component parts and parts' relationships. Part numbers and names may be shown on illustrations or separately listed. When the illustrations omit the part numbers and names, both the illustrations and separate listings shall cross-reference illustrated part to listed part.

5.3 Format.

5.3.1 Wherever possible, commercial manuals will be incorporated without change in either content or format. The commercial manuals may be bound without disassembly in the facility manual or may be disassembled and applicable portions incorporated into existing manuals.

5.3.2 The manual may be divided into volumes to prevent the manual from becoming too bulky.

5.3.3 The test shall be specific, concise, and clearly worded to be easily understood by personnel involved in the operation, maintenance, and repair of the equipment.

5.3.4 The manual shall be oriented toward operation, maintenance, and repair of the equipment by the operators and maintenance personnel without the assistance of a manufacturer's representative.

5.4 Manuscript Review. Draft manuscript copies, in the format and number as specified, shall be provided to the Government for review (See 5.). Operating and maintenance procedures, including checkout, calibration, alignment, scheduled removal and replacement instructions, and associated checklists shall be validated against the system (or equipment) in the presence of Government personnel.

5.5 Posted Instructions. Besides the operation and maintenance manuals, the following diagrams and instructions shall be furnished and installed, framed under glass or approved plastic laminate and permanently posted within view of the installed system:

- Complete layout diagram to include all wiring controls, system components, plumbing, valves and regulators.
- Selective starting and stopping procedures.
- Checking procedure for normal operation.
- Abbreviated recommended preventive maintenance procedures.
- Emergency instructions.
- Warnings and precautions.

5.6 Field Instructions. After installation, startup, testing, and acceptance of the system, the contractor shall be required to supply the services of a competent representative for not less than 4 hr to instruct local maintenance and operating personnel in the proper operation and maintenance of the complete system.

6. CONCLUSIONS.

This report includes the minimum requirements for central dental HVE systems and associated centrally plumbed distribution networks for use in USAF dental health facilities. As standards for dental clinics change, these specifications may be revised at a future date upon joint evaluations by the DIS and the Armstrong Laboratory, Occupational Environmental Health Directorate, Health Physics Branch (AL/OEBZ). Any questions should be directed to USAF Dental Investigation Service, AL/AOCD, 2509 Kennedy Circle, Brooks AFB TX 78235-5117, AUTOVON 240-3502, Commercial (210) 536-3502.

Part XV

Section B

Central Dental High-Vacuum (HIVAC) Oral Evacuation Systems

1. INTRODUCTION

1.1 HIVAC System. The central dental high-vacuum (HIVAC) oral evacuation system is designed to build and sustain high vacuum pressures at very low air flow. Specifically, this system provides for safe removal of viscous fluids, suture materials, hard and soft-tissue debris from surgical wound sites, without damage to normal tissue or dislodgment of freshly formed blood clots. Inlets to the central system are located in dental treatment rooms (DTRs) of all dental disciplines that create open soft-tissue surgical wounds in their treatment procedures. All inlets are connected to a central piping network that operates as a dry-type system, with individual separators and relate hardware located in each using DTR. Clinical end items required for the clinical use of dental HIVAC system are not considered part of the distribution network since they are not the responsibility of the system and distribution network maintenance organization.

1.2 System Performance. The HIVAC system provides the same performance a the hospital surgical vacuum system used for hospital operating rooms. For dental clinics that are part of a composite health facility, the dental HIVAC service can be provided from the hospital surgical vacuum system or medical vacuum system.

1.3 Minimum Requirements. The guidelines provided are minimum requirements for safe, proficient, reliable, and cost-effective production and distribution of dental HIVAC systems essential to dental health-care delivery. The information provided is applicable to all HIVAC systems in new construction and system replacement projects. The information is intended to supplement and provide a basis for other design criteria, guide specifications, codes and specifically MIL-HDBK-1191, DOD Medical and Dental Treatment Facilities Design and Construction Guide.

1.4 Safety. The system and distribution network for HIVAC service in free-standing dental facilities are not used in flammable anesthetizing gas locations, are not used to scavenge anesthetic or other flammable or non-flammable gases, and are not provided in inpatient areas. Therefore, the dental HIVAC system and distribution network are not within the jurisdiction of National Fire Protection Association Standard 99.

2. DEFINITIONS

2.1 Actual Cubic Feet Per Minute (acfm). The unit volume of gas flow at operating pressure and temperature.

2.2 Clinical End Items. Devices that connect to the individual terminal inlet fixtures for clinical use of HIVAC service.

2.3 Facility Demand. The calculated maximum standard cubic feet per minute (scfm) capacity for which the system is sized, based on the total number of DTR terminal inlets and the simultaneous use factor.

2.4 HIVAC Centrally Piped Distribution Network. All central plumbing, valves, monitors, terminal inlet fixtures, and other specified components for distribution of HIVAC service; originating with the terminal outlet fixture, and terminating at the point of connection to the HIVAC system.

2.5 HIVAC System. A central assembly of vacuum producers, receiver, switches, valves, and other electrical, mechanical, gas, and fluid controls, components, and interconnections for the production of surgical vacuum service, and terminating at the point of connection to the HIVAC central distribution network.

2.6 Inches of Mercury (in. Hg). The unit of negative pressure or vacuum measurement.

2.7 Risers. Pipes connecting the terminal inlet fixtures to the trunk lines of the HIVAC distribution network.

2.8 Standard Cubic Feet Per Minute (scfm). The unit volume of gas flow at standard pressure and temperature (one atmosphere; 20° C [68° F]).

2.9 Terminal Inlet Fixture. A quick connect/disconnect or threaded, valved device for connection of clinical end items to the HIVAC central plumbing.

2.10 Trunk Lines. Pipes of the HIVAC distribution network that connect risers to the HIVAC system.

3. REQUIREMENTS

3.1 Support. The HIVAC system and distribution network are intended to support the requirement for specialized surgical vacuum service to specified locations and shall not be used for any other purpose.

3.2 Distribution. HIVAC service shall be distributed by the following:

Location	No. of Terminal Inlets
DTRs for oral surgery	One/DTR
DTRs for periodontia	One/DTR
DTRs for endodontia	One/DTR
Recovery Room	One/Bed

3.3 Facility Demand. The facility demand for the HIVAC system and distribution network shall be calculated as two SCFM for each DTR HIVAC terminal inlet fixture specified, multiplied by the appropriate simultaneous use factor selected from the following:

No. of DTR Terminal Inlets	Use Factor
1 - 6	1.0
7 - 10	0.8
Over 10	0.6

NOTE: Recovery Room terminal inlet fixtures are not used in facility demand calculations.

3.4 Vacuum Requirement. The HIVAC system and distribution network shall be capable of maintaining not less than 12 inch Hg vacuum pressure at the terminal most distant from the vacuum source when the calculated facility demand is drawn through the network by the system.

3.5 Components. All piping used for interconnections within the system shall be type "K", "L", or "M" ASTRONAUT B88 seamless copper tubing. All piping for the central distribution network shall be type "M" copper tubing. All fittings used for connecting copper tubing shall be wrought copper, brass, or bronze designed for brazed or soldered connection. All tubing joints shall be soft soldered (minimum 232.2° C [450° F] alloy). Component connections requiring threaded connections shall be installed by tinning the male pipe thread with soft solder, Teflon tape, or other suitable joint compound approved for vacuum plumbing joints.

3.6 Factory Representative. The installer shall furnish a factory-trained representative of the system manufacturer who shall inspect the system and distribution network installations; and who shall, after installation approval, assist in startup and testing, and in training of personnel responsible for system and network maintenance as elsewhere specified. The factory-trained representative shall not be required for the distribution network piping leak test prior to connection of the system.

3.7 HIVAC System.

3.7.1 The HIVAC system shall be supplied as a complete module or package with all components factory mounted on the system receiver, prewired and tested; delivered for four-point connection to vacuum input, vacuum output, electrical power, and remote control panel.

3.7.2 The HIVAC system shall contain, but not be limited to, the following major components:

- Vacuum pumps and motors
- Receiver
- Automatic pump lubricator

- Lubricant recovery device
- Lubricant reservoir
- Valves and interconnections
- Electrical controls and enclosure
- Remote control panel

3.7.3 The system shall be duplex, with two vacuum pumps (duplex) connected in parallel to a single receiver.

3.7.4 Each pump shall be sized to maintain the minimum vacuum specified while providing 100% of the calculated facility demand.

3.7.5 The pumps shall routinely and automatically start and operate alternately to maintain the calculated facility demand.

3.7.6 The pumps shall be equipped for automatic start of the second pump to maintain facility demand in the event of failure of one pump and to support a brief, unplanned, contingency demand on the system requiring both pumps to operate simultaneously.

3.7.7 The pumps shall be provided with means for remote manual selection of simultaneous operation to support known contingency demand (100% DTR inlet capability).

3.7.8 The pumps shall be electric motor powered, rotary, belt driven, oil lubricated, positive displacement, air cooled, sliding or hinged vane types.

3.7.9 Each pump shall be provided with an automatic oil feed device operating only during pump operation; an oil separator/recovery/recycling device; an oil reservoir, and a low oil level sensor.

3.7.10 Each pump and motor assembly shall be mounted on a separate subframe. Subframes shall be receiver mounted (tank-mount: horizontal receiver) with vibration isolators, and shall be provided with adjustable motor bases, cooling fan, V-belt drives, and belt guards.

3.7.11 All connections to pump inputs and outputs shall be flexible hose or flexible pipe to prevent vibration transmission.

3.7.12 The input side of each pump shall be provided with a manual gate valve for pump isolation and a directional flow (check) valve for back-flow prevention.

3.7.13 Each pump output line shall be joined to a common air discharge line which shall vent to the atmosphere exterior to the facility. A drip leg with a manual and an automatic condensate valve shall be provided in the common discharge line as close as possible to the pump output connections. Pump output lines and common discharge vent shall be sized for minimum backpressure. The outdoor end of the vent shall be protected against entry of insects, vermin, debris, and precipitation without creating back pressure.

3.7.14 The system receiver shall be an American Society of Mechanical Engineers (ASME) Code constructed negative pressure vessel with a 0-30 in. Hg vacuum gage, a vacuum relief valve, and a manual condensate drain valve.

3.7.15 The system receiver size shall be considered as a characteristic of pump size and volume of the central distribution network piping and shall be sufficient to limit system cycling to not more than six starts/hour/pump while maintaining the calculated facility demand.

3.7.16 The electric motors shall be standard National Electrical Manufacturers Association (NEMA) high efficiency, open drip-proof, 1800-rpm design with sealed bearings, rated 200, 230 or 460 VAC, 60 Hz, and three-phase.

3.7.17 The electric motor horsepower shall be adequate for the pump size required such that the rating for the motor is not exceeded to support the calculated facility demand.

3.7.18 Each motor shall be provided with a separate magnetic starter, circuit breaker, automatic low oil level switch and reset, manual on-off automatic selector switch, run indicator light, and run hour meter.

3.7.19 Other electrical controls shall include, but not be limited to, a low voltage transformer and circuit breaker sized to operate all system low voltage requirements; low voltage activated switching for remote selection of automatic alternation/simultaneous run/off conditions; lead and lag-vacuum sensors and switches; a NEMA control panel, and a labeled remote control panel.

3.7.20 The remote control panel shall provide remote automatic alternation/simultaneous run/off switching of the HIVAC system; a run indicator light, and a cancelable audible, noncancelable visual alarm for failed pump (low negative pressure) warning.

3.7.21 Lead and lag-vacuum sensors and switches shall be located, adjusted, and connected to control pump drive motors according to the following nominal vacuum pressures:

Switch Condition	Lead (first pump)	Lag (second pump)
On	17 in. Hg	15 in. Hg
Off	19 in. Hg	19 in. Hg

3.7.22 The lead switch shall start and stop the pump selected by the automatic alternator. The lag switch shall start and stop the second pump for automatic simultaneous operation to support a contingency demand beyond the capability of one pump; and to maintain the calculated facility demand in the event of failure of the alternator selected pump.

3.7.23 A negative pressure sensor and switch assembly shall be installed at the output side of the system receiver. The assembly shall be adjusted and connected to serve as a

failed pump monitor, activating the remote control panel alarm when system pressure falls to 15 in. Hg or less.

3.8 Centrally Piped Distribution Network.

3.8.1 Distribution network risers shall be sized to accommodate an input of not less than two SCFM through the served terminal input with the network maintaining not less than 12 in. Hg vacuum pressure.

3.8.2 Risers shall in no case be less than 1/4 inch inside diameter.

3.8.3 Distribution network trunk lines shall be proportionately sized along their lengths to accommodate an input of not less than two SCFM from each riser-connected terminal output.

3.8.4 Network trunk lines shall at no point be less than 1/2 inch nominal pipe size.

3.8.5 Distribution network piping shall be sized so that the network does not contribute more than 3 in. Hg pressure drop between the vacuum source connection and the most distant terminal input while supporting the calculated facility demand.

3.8.6 Terminal inlet fixtures shall be valved mechanisms conforming to the Diameter-Index Safety System (DISS) or other valved, quick-connect/disconnect type medical gas fixture not interchangeable with oxygen, nitrogen, nitrous oxide, or compressed air outlets.

3.8.7 Terminal inlet fixtures shall be appropriately labeled, flush, wall-mounted types located as specified.

3.9 Testing.

3.9.1 After installation of the distribution network piping and before connection to the vacuum source and terminal inlets the piping shall be blown clear with dental compressed air or with cylindered dry nitrogen and capped for pressure testing.

3.9.2 All pipe joints shall be cleaned of excess flux for leak testing.

3.9.3 Before closing of walls and connection to the system, the distribution network shall be tested for leakage by pressurizing with compressed air or nitrogen to 50 psig and sealed. Allowing for temperature variance, at the end of 24 hr, pressure loss shall not exceed 5 psig. If pressure does not hold, repairs shall be made and the network retested until the test criteria are satisfied.

3.9.4 After successful testing of the distribution network, the completed assembly of system and network shall be given a final installation leakage test. The system shall be started and run until shut down by the automatic controls, and vacuum in the network is in excess of 12

in. Hg. After 1 hr. and without restarting, vacuum loss in the system and network assembly shall not exceed 1.5 in. Hg. If test is failed, repairs shall be made and the test repeated until criteria are satisfied. After satisfactory leakage, all terminal inlets shall be tested individually to demonstrate a vacuum of 12 in. Hg, using a certified (certification traceable to the National Bureau of Standards) vacuum gage.

4. DOCUMENTATION

4.1 Instructions. The contractor shall supply two complete sets of the manufacturer's operating and maintenance instructions a specified in subparagraph 4.2 to the local maintenance organization who shall be responsible for system maintenance. Bound set covers shall be labeled with the system name, building number, contractor's name, and contract number.

4.2 General Information.

4.2.1 The manual shall include an overall description and purpose of the system or equipment. The function and purpose of each system component shall be described. The description shall include the intended use, capabilities, and limitations of the system or equipment. If the manual covers more than one model of a system or equipment, or systems or equipment modified by field change, a description of the differences shall be provided. Quick reference data shall be included and shall describe technical or design characteristics of the equipment. Examples of such data are:

- Descriptive (nameplate) data necessary to identify manufacturer, type, and model.
- Functional characteristics, such as: power and frequency requirements, voltage, and amperage demands, outputs, and modes of operation.
- Rated outputs, such as: horsepower, cubic feet per minute (cfm), and revolutions per minute (rpm).
- Special characteristics, such as: operating temperatures, pressure, heat dissipation, and humidity.

4.2.2 A warning page, consisting of more than vital warnings extracted from those shown throughout the manual, shall be assembled. The warning page shall be placed on the inside cover or in front of the initial page(s) of the manual (See 4.2.7).

4.2.3 Operating instructions shall include routine and emergency procedures (manual and automatic) and safety precautions. Limits to be observed in the starting, operating, stopping, or shutting down of the equipment or system shall be provided. Adequate illustrative material shall be provided to identify and locate operating controls and indicating devices. The function of each operating control and indicating device shall be included. Emergency operating instructions shall include alternate procedures to be followed when normal operation is not possible because of emergency conditions, such as power or lubricating oil failure. Emergency operating instructions and procedures shall be located for quick and ready reference.

4.2.4 Preventive maintenance information shall be provided. Use of special tools, materials, and test equipment shall be specified, including model/type designation, as appropriate. The following procedures shall be stressed, if applicable:

4.2.4.1 Periodic cleaning and lubrication information, types of cleaning agents or lubricants required, recommended intervals, such as monthly, quarterly, semiannually, or hours of operation shall be provided. Application points and capacity (required amounts) shall be identified. Pictorial format for lubrication is desirable. Cleaning and lubrication required during repair, replacement, and reassembly shall also be covered.

4.2.4.2 Instructions for inspection of equipment for damage and wear shall be included. Tabular or chart format is preferred and shall include, where applicable, allowable service limits, wear, backlash, end play, length and depth of scoring, and balance. These instructions shall be sufficiently complete to serve as standards by which experienced technicians may determine when parts may be continued in use and when they must be replaced.

4.2.4.3 Instructions shall be included for verification of system performance. The location of test connections and the values expected at these points shall be included, preferably in illustrative form. Data shall include a list of equipment required to accomplish the verification, such as temperature, vacuum, pressure, hydraulic, or pneumatic gages.

4.2.5 Failures that might occur during operation of equipment shall be listed. Troubleshooting data and fault isolation techniques shall state: (a) the indication or symptom of trouble; (b) the instructions necessary, including test hookups, to determine the cause; (c) special tools and equipment; and (d) methods for returning the equipment to operating conditions. Information may be in chart or in tabular format with appropriate headings.

4.2.6 Instructions shall be provided for all removal, repair, adjustment, and replacement procedures. Exploded and sectional views giving details of assemblies shall be provided, as necessary, to clarify the text. For mechanical items, dimensional information with tolerances, clearances, wear limits, maximum bolt-down torques, and in-place balancing or other means of reducing noise level, if required, shall be supplied.

4.2.7 Notes, cautions, and warnings shall be used to emphasize important and critical instructions where necessary. Notes, cautions, and warnings shall immediately precede applicable instructions, and shall be selected as follows:

NOTE: Concerns an operating procedure or condition which should be highlighted.

CAUTION: Concerns an operating procedure or practice which, if not strictly observed, could result in damage to, or destruction of equipment.

WARNING: Concerns an operating procedure or practice, which, if not strictly observed, could result in injury to personnel or loss of life.

4.2.8 Manuals shall contain all illustrations necessary to locate and identify components of operational and maintenance significance. Where necessary for clarity, illustrations shall show configuration and the removal and disassembly of parts. The following types of diagrams shall be included: schematic diagrams which show the arrangement of component devices or parts; wiring diagrams which show the connections of the circuit arrangement; and schematic piping diagrams which show the interconnection of components, of piping, tubing, or hose, and the direction of air flow.

4.2.9 Circuit diagrams for electronic units shall be provided to support maintenance and troubleshooting. Circuit diagrams shall cross-reference repair parts shown in test tables and parts lists. The function name of each stage or circuit, primary signal flow, test points, wave forms with pertinent characteristics, electrical characteristics of parts, name of each variable control, input and output connectors/terminals voltages and signals shall be specified. Voltage and resistance values measured with controls set for normal operation shall be shown for significant points, such as terminal boards and connectors. Interconnecting cable diagrams shall be furnished to show TO-FROM information, including any intermediate connections. Block diagrams shall be provided to support installation instructions, but shall not be substituted for necessary schematic diagrams.

4.2.10 Parts lists shall provide positive identification of parts necessary for support of the systems or equipment and shall include sufficient information to enable maintenance personnel to requisition replacement parts.

4.2.11 Clear and legible illustrations shall be provided to identify component parts and parts' relationships. Part numbers and part names may be shown on illustrations or separately listed. When the illustrations omit the part numbers and names, both the illustrations and separate listings shall cross-reference illustrated part to listed part.

4.3 Format.

4.3.1 Wherever possible, commercial manuals will be incorporated without change in either content or format. The commercial manuals may be bound without disassembly in the facility manual or may be disassembled and applicable portions incorporated into existing manuals.

4.3.2 The manual may be divided into volumes to prevent the manual from becoming too bulky.

4.3.3 The manual shall be oriented toward operation, maintenance, and repair of the equipment by the operators and maintenance personnel and without the assistance of a manufacturer's representative.

4.3.4 The text shall be specific, concise, and clearly worded to be easily understood by personnel involved in the operation, maintenance, and repair of the equipment.

4.4 Manuscript Review. Draft manuscript copies, in the format and number as specified, shall be provided to the Government for review. (See 4.) Operating and maintenance procedures, including checkout, calibration, alignment, scheduled removal and replacement instructions, and associated checklists shall be validated against the system (or equipment) in the presence of Government personnel.

4.5 Posted Instructions. Besides the operation and maintenance manuals, the following diagrams and instructions shall be furnished and installed, framed under glass or approved plastic laminate, and permanently posted within view of the installed system:

- Complete layout diagram to include all wiring, controls, system components, plumbing, valves, and regulators.
- Selective starting and stopping procedures.
- Checking procedure for normal operation.
- Abbreviated recommended preventive maintenance procedures.
- Emergency instructions.
- Warnings and precautions.

4.6 Field Instructions. After installation, startup, testing, and acceptance of the system, the contractor shall be required to supply the services of a competent representative for not less than 4 hr. to instruct local maintenance and operating personnel in the proper operation and maintenance of the complete system.

5. CONCLUSIONS

This report includes the minimum requirements for central dental HIVAC systems and associated centrally plumbed distribution networks for use in USAF dental health facilities. As standards for dental clinics change, these specifications may be revised at a future date upon joint evaluations by the DIS and the Armstrong Laboratory, Occupational Environmental Health Directorate, Health Physics Branch (AL/OEBZ). Any questions should be directed to USAF Dental Investigation Service, AL/AOCD, 2509 Kennedy Circle, Brooks AFB TX 78235-5117, AUTOVON 240-3502, Commercial (210) 536-3502.

Part XV

Section C

Central Dental Surgical Handpiece Drive Air (SHDA) Systems

1. INTRODUCTION

1.1 Surgical Handpiece Drive Air. Surgical handpiece drive air (SHDA) is a cost-effective substitute for bottled nitrogen used to power pneumatic surgical handpieces. These high torque instruments are required to support routine exodontic procedures performed in dental treatment rooms (DTRs) designated for oral surgery in free-standing USAF dental clinics. Surgical handpiece drive air is not used for breathing or respiratory support of any kind, is not mixed with oxygen, and is not exhausted into the pharynx from powered instruments. Surgical handpiece drive air and the associated system and distribution network herein specified are a power source for surgical handpieces and are not an oilless medical air system. Therefore, National Fire Protection Association (NFPA) Standard 5F does not apply.

1.2 Equipment Demand. Surgical handpieces require a drive gas of higher constant pressure and significantly lower dew point than that specified for dental compressed air. The volume of SHDA required for facility support does not justify the increased equipment and energy costs required to increase dental compressed air quality and pressure parameters to satisfy SHDA standards.

1.3 System Functions. The SHDA system functions as a pressure boosting and drying unit for a portion of prerefined air (dental compressed air), producing drive gas of specified quality and pressure required by surgical rotary instruments.

1.4 Guidelines. The guidelines provided are minimum requirements for safe, proficient, reliable, and cost-effective production and distribution of SHDA of the quality, pressures, and flow rates essential to dental health care delivery. The information provided is applicable to all SHDA systems in new construction and system replacement projects and is intended to supplement and provide a basis for other design criteria, guide specifications, codes, and specifically MIL-HDBK-1191, DOD Medical and Dental Treatment Facilities Design and Construction Guide.

2. DEFINITIONS

2.1 Surgical Handpiece. Gas-operated rotary instruments intended specifically for use in oral surgery procedures, and designed for operation using Grade J nitrogen as classified by the Compressed Gas Association Air of Equivalent Purity.

2.2 Surgical Handpiece Drive Air. Dental compressed air which has been further processed to provide compressed air of specified quality, quantity, and pressure essential for the safe and proficient operation of surgical handpieces described herein.

2.3 Surgical Handpiece Drive Air System. An assembly composed of air pressure boosting device(s), receiver, dryer, filter, regulator, and all other electrical, mechanical and fluidic devices, and interconnections for the production, refinement, storage, monitoring, and initial regulation of surgical handpiece drive air; designed and sized for intermittent operation; and terminating at the point of connection to the surgical handpiece drive air central distribution network.

2.4 Centrally Piped Distribution Network. All central plumbing and station outlet fixtures for distribution of surgical handpiece drive air, originating at the system regulator outlet and terminating at the station fixture outlet.

2.5 Station Outlet Fixture. An endpoint of the centrally piped surgical handpiece drive air distribution network consisting of a wall-mounted quick connect/disconnect device approved for use with high pressure nonflammable gas, for user connection.

2.6 System Demand. The maximum flow rate, at maximum system pressure, required of the system to maintain the specified network demand and the system dryer purge air requirement, per station outlet fixture.

2.7 Network Demand. The specified intermittent flow rate, at station pressure, required through the centrally piped distribution network to support the oral surgery DTRs programmed.

2.8 Purge Air Demand. The air-flow rate (maximum is specified), at manufacturer's specified pressure, required for reactivation/regeneration of desiccant media in the system regenerative desiccant dryer during one regenerating cycle (one column regeneration).

2.9 Station Demand. The intermittent flow rate, at station pressure, drawn from an active station outlet fixture by a surgical handpiece. The maximum rate does not exceed 6 cubic feet per minute (cfm) at station pressure. The use interval does not exceed 3 min/15-min period per station outlet fixture.

2.10 Minimum System Pressure. The specified minimum pressure limit permissible in the system, which may occur for brief periods during recovery from peak system demand.

2.11 Booster Cut-in Pressure. The system pressure (minimum is specified) at which the booster device(s) is (are) switched on. Booster cut-in pressure shall be higher than minimum system pressure in order to assure that boosters are operating during peak demand and recovery periods before minimum system pressure is reached.

2.12 Maximum System Pressure (Booster Cut-out Pressure). The maximum design pressure (minimum is specified) in the system, at which pressure the booster(s) is (are) switched off.

2.13 System Pressure Differential. The difference in pressure (maximum is specified) between maximum system (booster cut-out) pressure and booster cut-in pressure.

2.14 Station Pressure. The sustained specified pressure, within specified tolerance, required at each station outlet fixture of the centrally piped distribution network.

3. REQUIREMENTS

3.1 Planned DTRs. U.S. Air Force dental facilities in which oral surgery DTRs are programmed shall be provided with a separate compressed air system and distribution network to supply surgical handpiece drive air to oral surgery DTRs.

3.2 Equipment Design. Surgical handpiece drive air, source systems, and centrally piped distribution network to supply surgical handpiece drive air to oral surgery DTRs.

3.3 Surgical Handpiece Drive Air.

3.3.1 Source air for the production of surgical handpiece drive air shall be dental compressed air.

3.3.2 The quality of surgical handpiece drive air relative to specific contaminants shall be as per the following limits:

Contaminant	Limit
A. Water	Dry to a pressure dew point of -40° C (-40°F), at not less than 150 psig.

Reference: American National Standards Institute Standard Z 86.1, 1973; and Compressed Gas Association (CGA) Pamphlet G-7.1.

B. Condensed Hydrocarbons	Not more than 0.1 parts per million (ppm) by weight (wt/wt) or 0.1 mg/L.

Reference: CGA Specification G-10.1 (Grade J).

C. Permanent particulates: Less than 1.0 ppm wt/wt or 1.0 mg/L.

Reference: CGA Specification G-10.1 (Grade J).

3.3.3 The network demand for surgical handpiece drive air shall be according to the number of oral surgery (OS) DTRs programmed as per the following:

Number of OS DTRs	Network Demand (CFM)
1-2	6
3-4	12
5 and over	18

3.3.4 Minimum system pressure shall not be less than 150 psig.

3.3.5 Booster cut-in pressure shall not be less than 60 psig.

3.3.6 The maximum system pressure shall not be less than 170 psig, and shall be compatible with pressure limits recommended by the system dryer manufacturer.

3.3.7 The system pressure differential shall not exceed 10 psig.

3.3.8 The station pressure for surgical handpiece drive air at each station outlet fixture shall be as follows:

Designation	Pressure	Tolerance
SHDA 100	100 psig	+10, -0 psig

3.3.9 Plumbing friction losses have not been included in specified pressure and demand values and must be added to specified values where required by standard engineering practice to assure specified station outlet performance.

3.4 Surgical Handpiece Drive Air System.

3.4.1 The system shall include, but not be limited to, the following components listed in downstream order:

- Air pressure booster device(s)
- Air receiver
- Regenerative desiccant column dryer
- Afterfilter
- Pressure regulator
- Low pressure monitor and warning device

3.4.2 Pressure Boosting Devices.

3.4.2.1 The system shall be provided with one or more boosters with provisions for automatic operation. Multiple booster systems shall not be duplexed, but shall have provisions for automatic simultaneous operation.

3.4.2.2 Boosters shall be one- or two-stage, single-or double-acting units, powered by pneumatic, electric, hydraulic means, or by a combination of these means.

3.4.2.3 Boosters shall not be powered by dental compressed air.

3.4.2.4 Boosters shall not contribute lubricating material to the booster output air.

3.4.2.5 Boosters shall be provided with drive power input and air output disconnects and/or valves for isolation during maintenance.

3.4.2.6 Booster/power unit assemblies shall be mounted on resilient vibration isolator pads. Vibration transmission to the source air system or to the other parts of the SHDA system shall be limited to less than 5% of the lowest frequency of vibration.

3.4.2.7 Booster intakes and outlets shall be connected to other components with flexible hose or flexible pipe.

3.4.3 The air receiver shall be an American Society of Mechanical Engineers (ASME) certified pressure vessel suitable for intended use. The receiver shall be provided with pressure-activated devices for automatic on and off switching of booster device(s); a pressure gage; a pressure relief (safety) valve; and automatic manual condensate drains.

3.4.4 Regenerative Desiccant Dryer.

3.4.4.1 The dryer shall be a dual tower (column) heatless type with provisions for fully automatic operation.

3.4.4.2 The dryer shall be designed and installed such that no plumbing, interconnections or accessory device removal is required for recharging towers with desiccant.

3.4.4.3 Regeneration of dryer desiccant shall consume not more than 15% of the final dried air product for each purge cycle.

3.4.4.4 Station pressure and demand shall be continuous without interruption by dryer purge cycling.

3.4.5 Afterfilters shall be replaceable cartridge types 100% efficient in retention of solids 9.025 μm in diameter.

3.4.6 The system regulator shall be a relieving type with an outlet control range from 0 to 150 psig, and with a pressure gage on the output side with a range from 0 to 200 psig.

3.4.7 Low Pressure Monitor and Remote Warning Device.

3.4.7.1 An air pressure monitoring device shall be connected in the air line between the system afterfilter and system regulator.

3.4.7.2 The monitor shall be equipped with an audible alarm and a test button. The monitor shall be adjusted and connected to activate the audible alarm and the remote warning device when system pressure falls below the specified minimum.

3.4.7.3 The labeled remote warning device shall be located in the administration/records/reception area of the dental clinic.

3.4.8 System Component Sizing Criteria.

3.4.8.1 Booster devices shall be of sufficient output capacity to provide full system recovery from minimum system pressure to maximum system pressure in not more than 15 min.

3.4.8.2 Air receivers shall be of standard, commercially available sizes and of sufficient capacity to provide not less than 3 min of continuous network demand at station pressure and sufficient purge air for one dryer column regeneration cycle. Booster(s) may be operating to assist supply of air. The system pressure shall not drop below the specified minimum.

3.4.8.3 All drying, filtering, and regulating components of the system shall be sized for maximum potential output of the booster(s) at maximum system pressure.

3.4.9 System Interconnections.

3.4.9.1 Unless otherwise specified, all system interconnecting piping shall be type "K" or "L" seamless copper tubing, washed, and degreased. All valves and fittings shall be wrought copper, brass, or bronze. All joints shall be made with silver brazing alloy except at valves or equipment requiring threaded pipe connections.

Threaded pipe connections shall be made by tinning male threads with soft solder.

3.4.9.2 System interconnections and components shall be suitable for not less than 190 psig working pressure and shall be tested with surgical dental compressed air or nitrogen to 250 psig.

3.5 Centrally Piped Distribution Network.

3.5.1 Pipe sizes for the central distribution network shall be adequate to assure delivery of not less 6 cfm, t specified station pressure, through each station outlet fixture.

3.5.2 Station outlet fixtures shall be hospital grade, high pressure, wall mounted, and Diameter Index Safety System (DISS) units manufactured for medical gas use.

3.5.3 The distribution of station outlet fixtures shall be one per oral surgery DTR.

3.5.4 All piping, fittings, and connections for the centrally piped distribution network shall be as per paragraph 3.4.9.1.

3.5.5 The centrally piped distribution network shall be suitable for not less then 150 psig of working pressure, and shall be tested with surgical handpiece drive air or nitrogen to 200 psig.

4. DOCUMENTATION

4.1. Instructions. The contractor shall supply two complete sets of the manufacturer's operating and maintenance instructions as specified in paragraph 4.2 to the local maintenance organization who shall be responsible for system maintenance. Bound set covers shall be labeled with the system name, building number, contractor's name, and contract number.

4.2 General Information.

4.2.1 The manual shall include an overall description and purpose of the system or equipment. The function and purpose of each system component shall be described. The description shall include the intended use, capabilities, and limitations of the system or equipment. If the manual covers more than one model of a system or equipment, or systems or equipment modified by field change, a description of the differences shall be provided. Quick-reference data shall be included and shall describe technical or design characteristics of the equipment. Examples of such data are:

• Descriptive (nameplate) data necessary to identify manufacturer, type, and model.

• Functional characteristics, such as: power and frequency requirements, voltage and amperage demands, outputs, and modes of operation.

• Rated outputs, such as: horsepower, cubic feet per minute, and revolutions per minute.

• Special characteristics, such as: operating temperatures, pressure, heat dissipation, and humidity.

4.2.2 A warning page, consisting of the more vital warnings extracted from those shown throughout the manual, shall be assembled and placed on the inside cover or in front of the first page(s) of the manual (See 4.2.7).

4.2.3 Operating instructions shall include routine and emergency procedures (manual and automatic) and safety precautions. Limits to be observed in the starting, operating, stopping, or shutting down of the equipment or system shall be provided. Adequate illustrative material shall be provided to identify and locate operating controls and indicating devices. The function of each operating control and indicating device shall be included. Emergency operating instructions shall include alternate procedures to be followed when normal operation is not possible because of emergency conditions, such as power or lubricating oil failure. Emergency operating instructions and procedures shall be located for quick and ready reference.

4.2.4. Preventive maintenance information shall be provided. Use of special tools, materials, and test equipment shall be specified, including model/type designation, a appropriate. The following procedures shall be stressed, if applicable:

4.2.4.1 Periodic cleaning and lubrication information, types of cleaning agents or lubricants required, recommended intervals, such as monthly quarterly, semiannually, or hours of operation shall be provided. Application points and capacity (required amounts) shall be identified. Pictorial format for lubrication is desirable. Cleaning and lubrication required during repair, replacement, and reassembly shall also be covered (See 4.2.6).

4.2.4.2 Instructions for inspection of equipment for damage and wear shall be included. Tabular or chart format is preferred and shall include, where applicable, allowable service limits, wear, backlash, end play, length and depth of scoring, and balance. These instructions shall be sufficiently complete to serve as standards by which experienced technicians may determine when parts may be continued in use and when they must be replaced.

4.2.4.3 Instructions shall be included for verification of system performance. The location of test connections and the values expected at these points shall be included, preferably in illustrated format. Data shall include a list of equipment required to accomplish the verification, such as temperature, vacuum, pressure, hydraulic, or pneumatic gages.

4.2.5 Failures that might occur during operation of equipment shall be listed. Troubleshooting data and fault isolation techniques shall state: (a) the indication or symptom of trouble, (b) the instructions necessary, including test hookups, to determine the cause, (c) special tools and equipment, and (d) methods for returning the equipment to operating conditions. Information my be in chart or tabular format with appropriate headings.

4.2.6 Instructions shall be provided for all removal, repair adjustment, and replacement procedures. Exploded and sectional views giving details of assemblies shall be provided, as necessary, to clarify the text. For mechanical items, dimensional information with tolerances, clearances, wear limits, maximum bolt-down torque, and in-place balancing or other means of reducing noise level, if required, shall be supplied.

4.2.7 Notes, cautions, and warnings shall be used to emphasize important and critical instructions where necessary. Notes, cautions, and warnings shall immediately precede the applicable instructions, and shall be selected as follows:

NOTE: Concerns an operating procedure or condition which should be highlighted.

CAUTION: Concerns an operating procedure or practice which, if not strictly observed, could result in damage to, or destruction of equipment.

WARNING: Concerns an operating procedure or practice which, if not strictly observed, could result in injury to personnel or loss of life.

4.2.8 Manuals shall contain all illustrations necessary to locate and identify components of operational and maintenance significance. Where necessary for clarity, illustrations shall show configuration and the removal and disassembly of parts. The following types of diagrams shall be included: Schematic diagrams which show the arrangement of component devices or parts; wiring diagrams which show the connections of the circuit arrangement; and schematic piping diagrams which show the interconnection of components, of piping, tubing, or hose, and the direction of air flow.

4.2.9 Circuit diagrams for electronic units shall be provided to support maintenance and troubleshooting. Circuit diagrams shall cross-reference repair parts shown in test tables and parts lists. The function name of each stage or circuit, primary signal flow, test points, wave forms with pertinent characteristics, electrical characteristics of parts, name of each variable control, input and output connectors/terminals voltages,

and signals shall be specified. Voltage and resistance values measured with controls set for normal operation shall be shown for significant points, such as terminal boards and connectors. Interconnecting cable diagrams shall be furnished to show TO-FROM information, including any intermediate connections. Block diagrams shall be provided to support installation instructions, but shall not be substituted for necessary schematic diagrams.

4.2.10 Parts lists shall provide positive identification of parts necessary for support of the systems or equipment and shall include sufficient information to enable maintenance personnel to requisition replacement parts.

4.2.11 Clear and legible illustrations shall be provided to identify component parts and parts' relationships. Part numbers and part names may be shown on illustrations or separately listed. When the illustrations and separate listing shall cross-reference illustrated part to listed part.

4.3 Format.

4.3.1 Wherever possible, commercial manuals will be incorporated without change in either content or format. The commercial manuals may be bound without disassembly in the facility manual, or may be disassembled and applicable portions incorporated into existing manuals.

4.3.2 The manual may be divided into volumes to prevent the manual from becoming too bulky.

4.3.3 The manual shall be oriented toward operation, maintenance, and repair of the equipment by the operators and maintenance personnel without the assistance of a manufacturer's representative.

4.3.4 The text shall be specific, concise, and clearly worded to be easily understood by personnel involved in the operation, maintenance, and repair of the equipment.

4.4 Manuscript Review. Draft manuscript copies, in the format and number as specified, shall be provided to the Government for review (See 4.). Operating maintenance procedures, including checkout, calibration, alignment, scheduled removal and replacement instructions, and associated checklists shall be validated against the system (or equipment) in the presence of Government personnel.

4.5 Posted Instructions. Besides the operation and maintenance manuals, the following diagrams and instructions shall be furnished and installed, framed under glass or approved plastic laminate, and permanently posted within view of the installed system:

- Complete layout diagram to include all wiring, controls, system components, plumbing, valves, and regulators.

- Selective starting and stopping procedures.

- Checking procedure for normal operation.

- Abbreviated recommended preventive maintenance procedures.

- Emergency instructions.

- Warnings and precautions.

4.6 Field Instructions. After installation, startup, testing, and acceptance of the system, the contractor shall be required to supply the services of a competent representative for not less than 4 hr to instruct local maintenance and operating personnel in the proper operation and maintenance of the complete system.

5. CONCLUSIONS

This report includes the minimum requirements for central dental SHDA systems and associated centrally plumbed distribution networks for use in USAF dental health facilities. As standards for dental clinics change, these specifications may be revised at a future date upon joint evaluations by the DIS and the Armstrong Laboratory, Occupational Environmental Health Directorate, Health Physics Branch (AL/OEBZ). Any questions should be directed to USAF Dental Investigation Service, AL/AOCD, 2509 Kennedy Circle, Brooks AFB TX 78235-5117, AUTOVON 240-3502, Commercial (210) 536-3502.

Part XV

Section D

Dental Compressed Air (DCA) Systems

1. INTRODUCTION

1.1 This document replaces Central Dental Compressed Air (DCA) Systems (USAFSAM-TR-86-7, May 1986) and Central Dental Surgical Handpiece Drive Air (SHDA) Systems (USAFSAM-TR-86-8, May 1986). It also includes data obtained from a survey of 128 compressed air systems (DIS Project 91-06).

1.2 Section 2 of this document discusses air quality requirements of the DCA System. Section 3 discusses the varying components of the DCA System. Unique problems that may be of interest to some installations are addressed in Section 4. Finally, a brief conclusion, bibliography, glossary, list of company addresses, and several component checklists are included. Acronyms used in the body of the report are defined in the glossary.

2. AIR QUALITY REQUIREMENTS

2.1 General.

2.1.1 DCA systems must provide clean, dry air to minimize corrosion and rusting of dental equipment, to prevent contamination of oral structures, and to maximize power from air driven instruments. Thus, they are unique compared to many other compressed air systems.

2.1.2 DCA is used to power dental handpieces, sandblasters, power lifts, etc. It does not supply breathable air and is never used for life support systems. Medical Compressed Air Systems are strictly regulated as to allowable concentrations of carbon monoxide, carbon dioxide, dew point, etc. It is expensive to purchase and maintain the equipment needed to purify and monitor medical air. DCA is not required to meet the same stringent standards as Medical Compressed Air.

2.1.3 The major contaminants of compressed air are condensed water vapor, oil (occasionally referred to as condensed hydrocarbons), and particulates.

2.2 Limits of Water Vapor Contamination.

2.2.1 Water, in its gaseous form, is not a problem because it behaves essentially as any other gas. It is when this water vapor condenses into water droplets that problems begin. Condensed water can cause corrosion, erosion of surfaces, loss of lubricant, reduced power output from air-powered equipment, and contamination of tooth

surfaces intended for bonding. For compressed air systems, the amount of water vapor in the air is measured in terms of the air's dew point.

2.2.2 For DCA, the dew point should not be greater than 4° C (38° F) at 7 kg/cm^2 (100 psig). When air is expanded back to atmospheric pressure (e.g., discharging air from a 3-way syringe), it will have a dew point of 16° C (-4° F) (equivalent to a relative humidity of 3%). This air will quickly dry moist surfaces and will eliminate most problems due to water condensation in the dental clinic.

NOTE: If the air lines are routed through unheated areas which are exposed to temperatures less than 0° C (32° F), the dew point should be lower (see Special Topic #4.5).

2.3 Limits of Oil Contamination. Generally, oil contamination is introduced by the compressor. The degree of contamination is measured in parts per million by weight (ppm w/w). The maximum acceptable limit for oil in DCA is 0.05 ppm w/w.

2.4 Limits of Particulate Contamination. Particulate contaminants must be filtered down to at least 1 micrometer (μm) before entering the building's air lines.

2.5 Air Pressure Requirements.

2.5.1 The DCA system must be able to provide air pressure at the Dental Treatment Room (DTR) between 5.6 - 6.3 kg/cm^2 (80-90 psig). For clinics using the DCA for surgical handpieces, refer to Special Topic #4.4. Some dental laboratory air stations require a reduced pressure between 1.8 - 2.2 kg/cm^2 (25-30 psig). This pressure can be obtained from the higher pressure DCA system through the use of an air regulator near the point of use.

2.5.2 When air flows though air lines and equipment, its pressure decreases. This pressure loss must be considered when setting and adjusting the DCA pressure settings. For a typical system, during full flow conditions, the average pressure loss and final pressure would be:

kg/cm^2	psig	
7.00	100	(DCA's minimum initial air pressure)
-.14	-2	(aftercooler's pressure drop)
-.35	-5	(refrigerated dryer's pressure drop)
-.28	-4	(filters' pressure drop)
-.35	-5	(pressure drop due to building's air lines)
5.88	84	(final pressure at the DTR)

NOTE: When designing a system for a new facility where there are long air line (i.e., >15 m [50 ft.]), most mechanical engineers allow for a 1% loss in pressure per 3 m (10 ft.) of line.

2.5.3 The DCA system should consist of a lead and a lag compressor. The lead compressor is the first to start as the air pressure falls; the lag compressor starts at a lower pressure if the lead compressor cannot supply enough air. In this example, the lead compressor would be set to start at 8.1 kg/cm^2 (115 psig) and run until it reached 9.5 kg/cm^2 (135 psig). The lag compressor should be set to start at 0.7 kg/cm^2 (10 psi) lower than the lead compressor. Therefore, the lag compressor would be set to start at 7.4 kg/cm^2 (105 psig) and stop at 8.8 kg/cm^2 (125 psig). As the coalescing filters fill with debris and liquid, the pressure at each compressor may change as much as 0.7 kg/cm^2 (10 psi); thus, the lead and lag compressors' starting and stopping pressures may need to be set as much as 1.4 kg/cm^2 (20 psi) higher. The final pressure to the building's air lines is kept constant by a regulator placed after the filters and dryer (see Figure 1).

2.6 Air Flow Requirements. The suggested air flow requirement for each DTR is based on a survey of existing DCA Systems and is 57 lpm (2.0 cfm) at 7 kg/cm^2 (100 psig) (measured at each compressor). Thus, the total compressor capacity (2 compressors) should be 113 lpm (4 cfm) per DTR. This value takes into account the random air flow demands due to high-speed handpieces, low-speed handpieces, and three-way syringes used by the dental clinic. If the dental clinic is equipped with an Air Venturi System (AVS) or any air-operated evacuation system instead of central vacuum, each DTR's demand will be increased by 127 lpm (4.5 cfm) to 184 lpm (6.5 cfm) at 7 kg/cm^2 (100 psig). The air demands of an attached dental laboratory are minimal and will generally be met without increasing the size of the DCA system. If the dental laboratory is remote, or otherwise requires a separate compressed air system, a total of 113 lpm (4.0 cfm), at 7 kg/cm^2 (100 psig) is required.

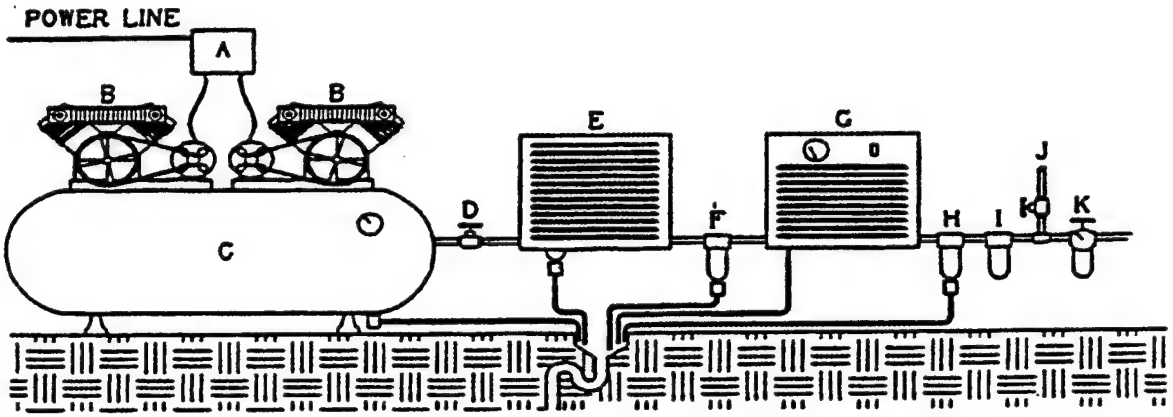
3. COMPONENTS

3.1 Compressed Air System, General Design. A DCA System is shown in Figure 1. Note that although the two compressors utilize one air receiver, they must function separately. If one compressor fails, the other could serve as a backup, thus, preventing total loss of air. Each of these sub-systems will be discussed in detail below.

3.2 Control Panel.

3.2.1 The control panel consists of an alternator that operates each compressor alternately (i.e., runs the first compressor one time and the other compressor the next time). The panel also controls the function of both the lead and lag compressors. If the compressors were not alternated, mechanical wear would not be equal and the lesser used compressor would be more susceptible to corrosion. Eventually, it could fail.

3.2.2 The DCA System should also contain a low pressure monitor and test button that sounds an audible alarm when the air receiver's air pressure falls below 7 kg/cm^2 (100 psig). The audible alarm should be located in the administration, records, or reception area of the dental clinic.



A - Control Panel with Alternator
B - Compressors with Intercoolers
C - Air Receiver with Drain & Gauge
D - Service Valve
E - Aftercooler with Separator & Drain
F - General Purpose Coalescing Filter
G - Refrigerant Dryer
H - Final Coalescing Filter
I - Vapor Removal Filter
J - Air Sample Tap
K - Pressure Regulator

Figure 1. Dental compressed air system.

3.3 Compressors.

A. All DCA systems must have two equally-sized compressors, each having the capability to handle the entire load of the dental clinic with no more than a 65% duty cycle. This configuration gives adequate reserve capacity and sufficient cool down time to prevent overloading. Under normal operating conditions, with both compressors alternately running, the actual duty cycle should not exceed 33% for each compressor. As mentioned previously, the two compressors can utilize one air receiver (Fig. 1) or separate receivers. Compressors using oil lubrication must have a low oil or a high temperature shutdown switch.

B. Heat of Compression. Compressing air raises its temperature. This temperature rise creates additional resistance to compression, reduces efficiency, increases mechanical wear, increases operating costs, and lowers reliability. For example, a single-stage compressor raises air pressure from atmospheric to the final pressure in one stroke. Single-stage compressors may have more than one piston, but each piston raises the air to its final pressure in one piston stroke. Since there is very little cooling during compression, these units produce very hot air, about 232° C (450° F) for 6.3 kg/cm^2 (90 psig) air. Therefore, single-stage compressors should be limited to air pressures of 5.6 kg/cm^2 (80 psig) or less. They are not recommended for DCA systems.

C. Heat Reduction

1. There are two major methods of heat reduction: multi-staging and injection cooling. One of these methods should be employed to reduce heat for pressures above 5.6 kg/cm^2 (80 psig).

2. Dental air compressors which utilize multi-stage compression are known as two-stage compressors. In the first stage, the piston compresses the air from atmospheric pressure to about 2.8 - 3.5 kg/cm^2 (40 - 50 psig). The air is then cooled by an intercooler and compressed to its final pressure in the second stage. Air intercoolers are commonly used on dental compressors. Water intercoolers, even though more effective, are options that are not usually not needed.

3. Injection cooling works by injecting a liquid (usually oil or water) with the air into the compressor, then compressing the mixture, and finally separating the liquid from the air. The liquid may then be discharged or cooled as reused. This process is successful in removing most of the heat because the liquid has more mass and a higher specific heat than the compressed air.

3.3.1 Electric Motors

3.3.1.1 The voltage, phase, and frequency (50/60 Hz) of the motors used in the DCA system must match the electrical supply. Using a boost transformer to raise building voltage to match a motor is more expensive and less reliable than ordering the correct motor to match the electrical supply. Boosters are not recommended. Triple-phase motors are preferable over their single-phase counterparts since they give better performance, are less expensive, and are more reliable.

3.3.1.2 Starting an electric motor produces a very large momentary surge of current (about 5 times the normal current load) causing additional heating of the motor. Motors started too often will overheat and eventually fail prematurely. Motors used for DCA should be limited to less than 6 start-ups per hour. Unnecessary motor start-ups can be reduced by installing a correctly sized receiver or by running the motor continuously using valves within the compressor to control the air flow (i.e., using a constant-speed control and loading and unloading the compressor).

3.3.2 Other Factors Concerning Compressors

3.3.2.1 Special considerations must be made for clinics at elevations above 1500 meters (5,000 feet). Air is thinner at higher elevations; consequently, compressor capacity (in kg/cm^2 or cfm) drops. The thinner air will not properly cool standard motors at higher elevations. Special compressors and motors are often required. The manufacturer should be consulted for the correct configuration of equipment.

3.3.2.2 Compressors are most commonly mounted on top of the air receiver (duplex tank mounted); however, they can also be remotely located on skids. If compressors are remotely located, the air lines between the compressor and the air receiver must have pressure relief valves to maintain a constant pressure between the compressor and receiver and to prevent rupturing the air line.

3.3.2.3 Before installing a DCA system, the physical size and weight of the compressors must be considered. There must be enough room to move them through doors, through access shafts, down hallways, etc. Special installation arrangements may be required. For example, a 3 hp. duplex tank-mounted compressor may weigh over 450 kg (1,000 lb.) and may be 1.8 m (6 ft.) long, .9m (3 ft.) wide, and 1.2 m (4 ft.) high.

3.3.3 Types of Compressors. There are many types of compressors that can be successfully used for DCS. To help demonstrate compressor efficiency at 7 kg/cm^2 (100 psig), specifications on 49 compressors made by 13 manufacturers were used to construct Figure 2. Many companies offered compressor types in at least two or three categories (i.e., lubricated reciprocating, nonlubricated reciprocating and rotary screw compressors). The ranges of data are shown by the bars. Figures 3, 4, and 5 are from a survey of 128 DCA Systems (DIS Project #91-06). Figures 3 and 4 represent the age of units in military clinics, not the life expectancy of these units.

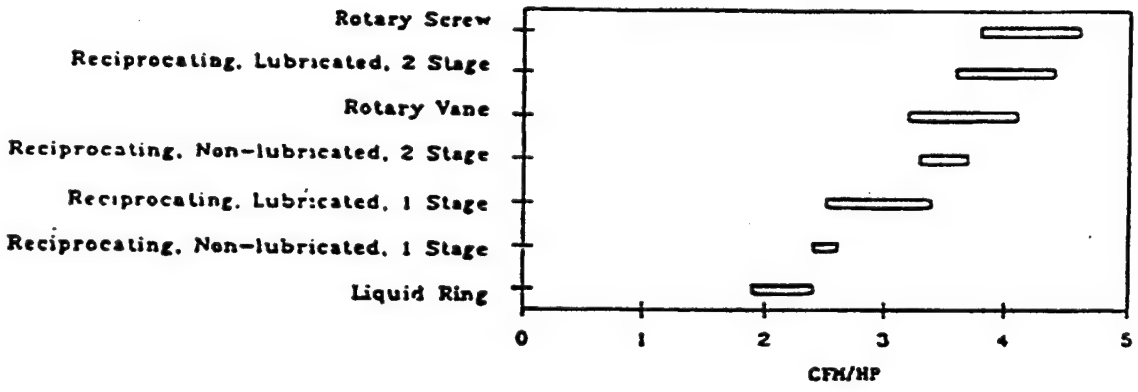


Figure 2. Air compressor efficiency.

3.3.4 Lubricated Reciprocating Compressors

3.3.4.1 In the lubricated reciprocating compressor, a piston travels inside a cylinder which is lubricated with oil. As the piston moves up and down compressing the air, a small amount of oil vapor is transferred with the compressed air. This oil vapor is later removed by a series of filters. Reciprocating compressors are

available in single and two-stage configurations. For most dental applications, the two-stage compressor is preferable.

3.3.4.2 Two-stage lubricated compressors are initially, as a group, some of the least expensive compressors, and they offer very good reliability as evidenced from the survey (DIS Project No. 91-06). Although variable, the approximate cost for maintenance of a two-stage compressor is $900 a year (provided the maintenance is accomplished as recommended by the manufacturer). They are among the most efficient compressors and, according to the survey, have long operational lives. They can be operated over a large range of pressures (generally up to 14 kg/cm^2 [200 psig]).

3.3.5 Nonlubricated Reciprocating Compressors

3.3.5.1 The non lubricated reciprocating compressor operates on the same principle as the lubricated compressor except that the piston rings are made of a low friction material (usually a Teflon-composite). The piston walls are oil-less and all friction reduction between the piston and cylinders is due to the low friction piston rings. Generally, because of this design, these compressors cannot operate at as high a pressure as the lubricated reciprocating compressors and are usually limited to a maximum of 8.8 kg/cm^2 (125 psig). Once again, these compressors are available in single and two-stage configurations; the two-stage compressor is usually the better choice.

3.3.5.2 Nonlubricated reciprocating compressors are sometimes referred to as "oil-free" compressors. These compressors have wet sumps where the crankshaft is lubricated with oil; however, this sump oil is separated from the compression chamber by a distance piece and cannot enter the compression chamber. This type of compressor should be distinguished from the "oil-less" reciprocating compressors which have dry sumps with sealed bearings.

Type Compressor	AGE RANGE (Years)
Reciprocating, Lubricated	1 to 30
Reciprocating, Non-lubricated	0.5 to 20
Liquid Ring	1 to 26

Figure 3. Age of compressors currently in use (not life expectancy).

3.3.5.3 Because oil free air is necessary for DCA, nonlubricated (oil-free) compressors would seem an obvious choice. They do, however, have a number of disadvantages.

3.3.5.4 Compared to their lubricated counterparts, nonlubricated compressors are less efficient, may have p to 30% shorter operational lives, are more costly to operate, are less reliable, and initially cost about 50% more. If not used for an extended period of time, rust may form on the cylinder walls causing excess ring wear. Because they are not lubricated, these compressors require more frequent maintenance. The approximate cost for maintenance may be $1600 a year.

3.3.6 Liquid Ring Compressors.

3.3.6.1 The liquid ring compressor has a finned, squirrel cage-shaped rotor housed inside of a water filled casing. Through the rotation of the rotor, a ring of water is formed that follows the shape of the compressor's casing. As the rotor spins, water fills some of the rotor's chambers compressing the air into the discharge port. The chamber then rotates to the inlet port where the water empties from the chamber, bringing in fresh atmospheric air. As the rotor continues to rotate, the fresh air is compressed. This compression cycle repeats with each rotation. These compressors are designed for a specific pressure range and lose efficiency if operated outside of this range. Because of their design, these compressors produce a pulseless supply of compressed air. Moderately sized compressors (15 to 20 hp) are generally limited to pressures of about 7 kg/cm^2 (100 psig). Liquid ring compressors are only available in $\geq$ 7.5 hp.

3.3.6.2 Liquid ring compressors are injection cooled and do not require an aftercooler. They do not contain rubbing parts (e.g., piston rings against cylinder walls as in the reciprocating compressors) and are thus very reliable. In the simplest design, the water is used once and then discharged down the drain. In areas where water usage or cost reduction is important, the used water can be cooled, processed, and reused. Since the water ring eliminates most debris from the air, and since oil is not used, liquid ring compressors need only a general purpose coalescing filter (which should be able to remove particles larger than 1 μm) downstream from the air dryer.

3.3.6.3 Liquid ring compressors have long operational lives and produce essentially pulseless compressed air. However, they have a high initial cost (approximately 200% more expensive than lubricated reciprocating compressors) and are among the least efficient of compressors. The approximate cost to maintain these compressors may range from $800 - $1100 per year, not including parts.

3.3.7 Rotary Screw Compressors

3.3.7.1 Rotary screw compressors use two screw-shaped rotors which interdigitate with each other. Rotation of the rotors, along with oil injection, compresses the air. The injected oil creates a seal between the rotors and compression chamber, lubricates, and thus removes the heat of compression. These compressors are designed for a specific pressure range and lose efficiency if operated outside of this range.

3.3.7.2 Rotary screw compressors often run continuously, and the production of compressed air is controlled through the modulation of valves. This method of loading and unloading the compressor allows for precise control of air pressure without an excessive number of start-ups. During periods of low air usage, the compressor can also be set to shut-off and restart when needed.

3.3.7.3 The principal advantages of these compressors are their high reliability due to few moving parts, pulseless supply of compressed air, high efficiency, and reportedly long operational lives. Because of these reasons, rotary screw compressors have replaced approximately half of the industrial market share of reciprocating compressors. Rotary screw compressors are limited to 5 hp and larger. Pricing varies, but some brands of rotary screw compressors are competitively priced with their lubricated reciprocating counterparts.

3.3.8 Sliding-Vane Rotary Compressors. The sliding-vane rotary compressor contains an offset rotor which as slots that are fitted with rectangular vanes. As the rotor spins, the vanes move in and out to conform to the shape of the compressor body. Air is brought into the compressor, compressed and discharged with each rotation of the rotor. Oil injection, along with the intake air, cools the air, lubricates the rotor, and creates a seal between the rotor and the chamber. These compressors are designed for a specific pressure, and they lose efficiency if operated outside of this pressure. This type of compressor can be very quiet and is ideal where noise is a problem. If necessary, it can be placed in a small room or closet inside the clinic. Although these units offer good efficiency and a pulseless supply of compressed air, their production is limited to a few companies and they are too small (1 hp or less) for most institutional dental clinics.

3.4 Aftercoolers

3.4.1 Even with intercooling or oil injection cooling, compressed air can leave the compressor at temperatures as high as 149° C (300° F), which is too hot for an air dryer and could damage it. An aftercooler not only cools the air, but also condenses most of the compressed air's moisture.

3.4.2 For smaller compressors (where the combined size of both compressors is less than 15 hp) the compressed air is sent to the air receiver to be cooled before going to the air dryer. For larger compressors, the air receiver may not provide enough cooling, and an aftercooler is needed. The aftercooler may be located directly

after the receiver or between the compressor and the receiver. It should cool the compressed air to within 11° C (20° F) of room temperature. The aftercooler should also have a moisture separator with an automatic electrical drain valve. Aftercoolers can remove 60% or more of the compressed air's moisture.

3.4.3 Aftercoolers are available in air-cooled or water-cooled models. The air-cooled models are the most common and save the cost of water and descaling. The water-cooled models are smaller, more efficient, and cause less heating of room air. Water-cooled aftercoolers must have an automatic water valve.

3.4.4 Liquid ring compressors, regardless of size, do not require the use of aftercoolers.

3.5 Air Receivers

3.5.1 The air receiver cools the air, reduces compressor pulsations, and stores compressed air. The air receiver's size determines the number of compressor start-ups per hour. A smaller air receiver may require many starts per hour (more than 6) with the increased chance of electric motor overheating. preconfigured combinations of compressors and air receivers are optimal. If a separate air receiver must be bought, its approximate size should conform to the following formula:

- Receiver Size (liters; gallons) = 4 X LPM; ACFM of One Compressor at 7 kg/cm^2 ; 100 psig

- Receiver Size (liters; gallons) = 8 X LPM; ACFM of One Compressor at 3.5 kg/cm^2; 50 psig

NOTE: Receivers are usually sold in standard sizes. If the above formula gives a value between two standard sizes, the larger receiver should be selected.

3.5.2 The air receiver must be certified by the American Society of Mechanical Engineers (ASME) and should be galvanized inside and out to prevent rusting. Rust weakens the air receiver, clogs automatic drains, and causes downstream contamination. The air receiver must be equipped with a pressure gage, automatic electrical drain valve, safety valve, and service valve. The service valve allows isolation of the air receiver from the downstream system. The electronic drain valve should be adjusted to drain at regular intervals so that no more than approximately 60 ml (2 oz) of water collects in the receiver at any one time.

3.6 Air Filters

3.6.1 Air filters are used in conjunction with air dryers to condition DCA to its required purity. The major purpose of these filters is to remove oil vapor and, to a smaller extent, to remove excess moisture and particulates. Final filtration for particulates

must be removed at the point of use (e.g., DTR, laboratory) since particulates can easily originate within the building air lines. Both the general purpose and final coalescing filters must have automatic drains (electric drains are preferable due to their reliability) and differential pressure monitors (signals when the filter's cartridge needs replacement).

3.6.2 There are basically three types of filters used for DCA:

3.6.2.1 General Purpose Coalescing Filter. The general purpose coalescing filter removes particulates larger than 1 μm and removes gross oil and water aerosols. It is generally resistant to clogging and reduces the load on subsequent filters and the air dryer.

3.6.2.2 Final Coalescing Filter

3.6.2.2.1 The final coalescing filter removes particulates larger than 0.01 μm and removes oil carryover to less than 0.10 ppm w/w. It must always be preceded by a general purpose coalescing filter. The net effect of this filter is that it produces "technically oil-free air."

3.6.2.2.2 Below in Table 1 is a list of filters for DCA systems. The correct size of each filter is determined by the air flow of the DCA System; the company's literature must be consulted for proper sizing. This list should not be considered exhaustive.

TABLE 1. AIR FILTER SELECTION GUIDE

Company Name	General Purpose Coalescing Filter	Final Coalescing Filter	Vapor Removal Filter
Balston	Grade DX	Grade BX	Grade CI
Hankison	3100 Series	Aerosol	Hypersorb
Ingersoll-Rand	P-Series	C-Series	V-Series
Sullair	PF Puretech	PH Purellescer	PC Pureadsorber
Van Air	Grade B	Grade C	Grade RD
Wilkerson	Type B	Type C*	Type D **
Zurn	Particulate Filter, P	Coalescing Filter, C	Odorgard Filter, O

* Extremely High Efficiency Coalescer
**Critical Application Adsorption Filter

3.6.2.3 Vapor Removal Filter. The vapor removal filter is made up of activated charcoal that removes hydrocarbon impurities that patients could smell or taste; it removes oil vapors to less than 0.01 ppm w/w. In the case of lubricated compressors, this filter should always be preceded by a final coalescing filter. An air

sample tap should be placed downstream from this filter. The filter cartridge needs replacement when there is a detectable odor from this tap. The vapor removal filter is the only filter that does not need a drain or differential pressure monitor.

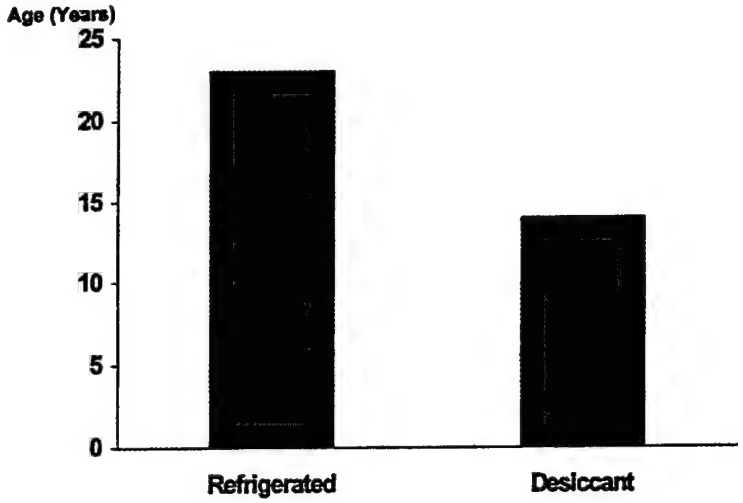


Figure 4. Age of dryers currently in use (not life expectancy).

3.7 Air Dryer

3.7.1 The amount of water vapor that air can contain without condensation varies with temperature and pressure. As the temperature rises air can hold more water vapor; conversely, as pressure rises, air holds less water vapor. Two types of dryers are usually employed to dry DCA. They are desiccant dryers and refrigerant dryers. Refrigerant dryers are preferred because they have less than one-third the occurrence of water in the compressed air (see Figure 5), or they are initially less expensive; and they require less maintenance than desiccant dryers. Desiccant dryers require replacement of their desiccant about once every 2 to 3 years.

3.7.2 Refrigerated dryers remove moisture by chilling compressed air to the required dew point. The moisture then condenses out, collects in a separator, and is discharged. These dryers are generally sized and adjusted to cool the compressed air to a dew point between 2 - 3°C (35 - 38° F). If the refrigerant dryer is set below 2° C (35° F), it is possible that the actual temperature in certain parts of the dryer may be at or below 0° C (32° F) which will result in ice formation and clogging of the air line.

3.7.3 The refrigerated dryer should be noncycling (continuous operation) and adjustable to prevent freezing of the air line. It should also have a high temperature warning light (to warn of compressor problems) and an outlet air temperature gage (to adjust and check the dew point).

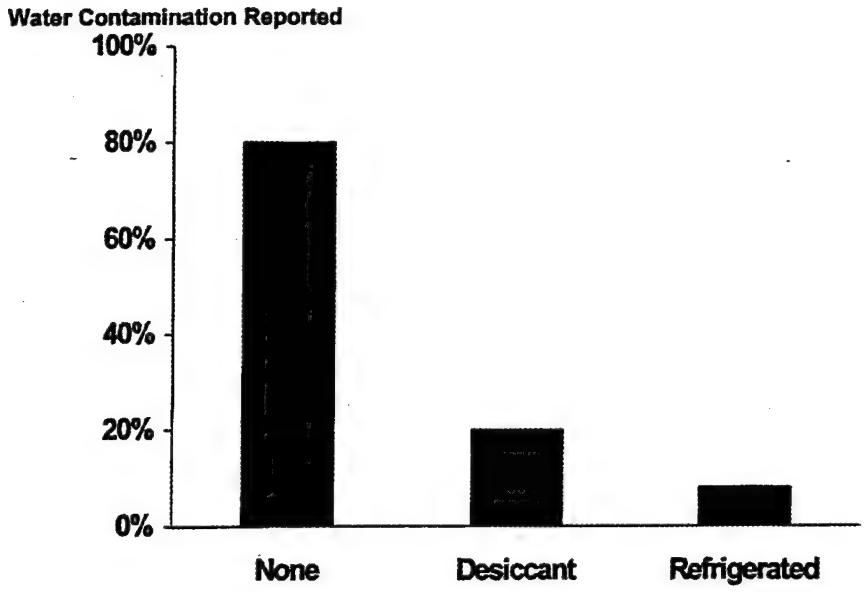


Figure 5. Water in compressed air by dryer type.

3.7.4 The dryer should be placed after the air receiver and before the air pressure regulator to allow the air receiver to cool the compressed air and smooth out compressor pulsations to help extend the life and efficiency of the dryer. In this location the dryer should be sized for at least 60% flow of both compressors.

3.7.5 Final oil vapor removal is most efficient if the air is cool. Some refrigerant dryers offer an oil coalescing filter inside the chiller to increase the effectiveness of the filter. If the dryer does not have this internal oil coalescing filter, the final coalescing filter should be placed as close to the outlet of the dryer as possible.

3.8 Air Pressure Regulator. An air pressure regulator with a 0-10.5 kg/cm^2 (0-150 psig) air gage must be placed after the air has been dried and filtered and before the air is sent to the clinic's air lines. The regulator must be sized to handle the full capacity of both compressors and must be able to regulate the final pressure between 0-10.5 kg/cm^2 (0-150 psig). This regulator damps out the pressure fluctuations due to the compressor cycling on and off, thus, keeping the clinic's air lines at the desired pressure. The regulator must be set higher than the pressure required at the DTR in order to account for the pressure drop that occurs during full air flow conditions. For properly sized air lines this pressure drop would be 0.35 kg/cm^2 (5 psig) or less. Therefore, for a 5.6 kg/cm^2 (80 psig) air pressure at the DTR, the regulator should be set at 6.0 kg/cm^2 (85 psig). If the air lines are undersized, the regulator may need to be set higher. For the regulator to work correctly, the input pressure must always be higher than its output. A pressure differential of at least 0.7 kg/cm^2 (10 psig) is usually sufficient.

3.9 Air Lines.

3.9.1 The building air lines should be ideally sized to carry the air flow of at least 113 lpm (4 cfm) at 7 kg/cm^2 (100 psig) to each user with no more than a 0.35 kg/cm^2 (5 psig) pressure drop from the DCA regulator to the furthest user. In large facilities, this may be difficult to achieve because of the allowable 1% per 3 m (10 ft) loss in line pressure. No building air line should be less than 13 mm (1/2 inch) in diameter. The air lines and all components must be rated to at least 10.5 kg/cm^2 (150 psig) working pressure. All air lines must be routed through heated areas to prevent exposure to temperatures below 4° C (40° F).

3.9.2 Pipes should be type "K" or "L" seamless copper tubing that has been washed and degreased. All valves and fittings should be wrought copper, brass, or bronze. All joints should be made with silver brazing alloy except for valves or equipment requiring threaded pipe connections. Threaded pipe connections should be made by tinning male threads with soft solder.

4. SPECIAL TOPICS

4.1 Wet Versus Dry Receiver.

4.1.1 The preferred design places the dryer after the air receiver (sometimes called a wet receiver configuration). This configuration allows the air receiver to cool the air and damp-out compressor pulsations. For smaller DCA systems the air receiver also functions as an aftercooler. To limit the water contained in the air receiver, it is equipped with an electronic drain. Because the air receiver stores compressed air and equalizes flow, the air dryer need only be sized to handle 60% of the capacity of both compressors.

4.1.2 A secondary design places the dryer before the air receiver (called a dry receiver configuration). This configuration has a number of disadvantages. The air leaving the compressor is hot; consequently, it must be cooled by a large aftercooler to within 3° C (5° F) of room temperature. This aftercooler must be equipped with a separator and automatic drain. The pulsations from a reciprocating compressor will cause increased stress on the dryer and can shorten its operational life. The dryer must also be sized to handle the full air capacity of both compressors because the air receiver is no longer functioning as an air flow buffer. The dry receiver design when compared to the standard wet receiver:

- Requires an aftercooler for all DCA Systems.
- Requires a larger aftercooler (3° versus 1.1° C or 5° versus 20° F temperature drop).
- Requires a larger dryer (100% versus 60% compressor capacity).
- Results in a shorter operation life for the dryer.

Also see Special Topic, #4.3.

4.2 Oil Contaminated Air Lines. The building's air lines can become contaminated by oil if the previous DCA System was not properly designed, or if an oil coalescing filter ruptures. This problem can be dealt with by first correcting the problem (e.g., installing or replacing the coalescing filters) then flushing the lines with a degreaser or installing a disposable coalescing filter at each dental unit. Balston makes a line of disposable coalescing filters (part number 9922-11-BX, approximately $17.00 each) that can be used at each DTR.

4.3 Sterile Compressed Air.

4.3.1 A frequently expressed concern is that the DCA system may become contaminated. The air receiver is commonly cited as the problem area. All compressed air systems collect water somewhere within the system. The important point is to design the system so that this water will collect in areas where it can be drained before appreciable bacterial or fungal growth occurs. Areas that are ideal for collecting and draining water are the aftercooler, receiver, filters, and dryer. If the DCA System is correctly designed and maintained, no more than a few ounces of water will collect before being drained off. With the use of electric drains, this water will be drained within an hour of collection. Note that wet receiver systems are acceptable even for medical grade compressed air.

4.3.2 The entire DCA cannot be made sterile. If sterile air is required, the only possible method is the use of sterile air filters in each DTR just prior to the point of use. These filters must be removable and sterilizable. All air lines after these filters must also be removable and sterilizable. Filters that meet the requirements of the Food and Drug Administration (FDA) for sterile air are available from Balston (see Balston's Bulletin P-90E) and Zander Filter Systems.

4.4 Compressed Air for Surgical Handpieces.

4.4.1 The quality of air described in this document will meet the requirements of most surgical handpieces (DynaDent, Hall, and Stryker). Sterility is not an issue since the air used to operate these handpieces is discharged well away from the surgical site. To meet the required air pressure for some surgical handpieces the main air pressure regulator will likely need to be set at a higher pressure (e.g., 8.1 kg/cm^2; 115 psig) and the lead and lag compressors' cut-in and cut-out pressures adjusted upward.

4.4.2 Adjusting the DCA pressure upward will slightly increase wear on the compressors and will result in a small increase in the use of air by other areas of the clinic. The advantages of using compressed air for surgical handpieces, however, usually outweigh the expense, danger and additional work involved with using tanks of compressed nitrogen as the source for operating the handpieces.

4.4.3 In the future, surgical handpieces will probably be predominately electrically powered.

4.5 Drying Air for Air Lines Exposed to Cold Conditions.

4.5.1 If the DCA lines are routed through unheated areas which are exposed to temperatures less than 0° C (32° F), the dew point of the compressed air must be at least 3° C (5° F) lower than the coldest temperature expected to avoid condensation and freezing in the air lines.

4.5.2 Two methods which may be used to obtain low dew points are drying at higher pressures or using desiccant dryers.

4.5.2.1 Pressure Method

4.5.2.1.1 Table 2 shows the relationship of air pressure versus dew point at constant temperature. By finding a dew point in the table under a specific pressure and reading across to the left, you can find the new dew point if that air were expanded to a lower pressure. For example, if air with a dew point of 3° C (38° F) at 8.4 kg/cm^2 (120 psig) is expanded to a pressure of 5.6 kg/cm^2 (80 psig), by reading across to the left on the table we can see that the air's new dew point will be -1° C (30° F). By reading further across to atmospheric pressure (0 psig) the air's dew point will be -22° C (-8° F).

4.5.2.1.2 For the few situations where air lines are exposed to low temperatures, (0° to -4° C; 32° to 25° F), adjustment of the air pressure at the dryer will be necessary. By increasing the air pressure at the dryer and keeping the pressure to the building air lines constant, a low dew point can be maintained in the air lines. For example (referring to Table 2), if the dryer is maintaining a dew point of 3° C (38° F) at a pressure of 180 psig, and the regulator reduces this air to a pressure of 80 psig, the dew point of the air will be -7° C (20° F). This dew point is sufficient to permit adequate flow though air lines exposed to temperatures as low as -4° C (25° F). If the air lines are exposed to temperatures below -4° C (25° F), a desiccant dryer will be needed.

TABLE 2. AIR PRESSURE

(psig)								kg/cm^2							
0	60	80	100	120	140	160	180	0	4.2	5.6	7.0	8.4	9.8	11.2	12.6
3	36	42	48	52	56	60	64	-19	2	6	9	11	13	16	18
1	34	40	46	50	54	58	62	-18	1	4	8	10	12	14	17
0	32	38	44	48	52	56	60	-18	0	3	7	9	11	13	16
-2	31	36	42	46	50	54	58	-19	-1	2	6	8	10	12	14
-3	30	35	40	44	48	52	56	-19	-1	2	4	7	9	11	13
-4	28	34	38	42	46	50	54	-20	-2	1	3	6	8	10	12
-6	26	32	36	40	44	48	52	-21	-3	0	2	4	7	9	11
-8	24	30	34	38	42	46	50	-22	-4	-1	1	3	6	8	10
-9	23	28	32	36	40	44	48	-23	-5	-2	0	2	4	7	9
-10	22	26	30	34	38	42	46	-23	-6	-3	-1	1	3	6	8
-12	20	24	28	32	36	40	44	-24	-7	-4	-2	0	2	4	7
-13	18	22	27	30	34	38	42	-25	-8	-6	-3	-1	1	3	6
-14	16	21	26	29	32	36	40	-26	-9	-6	-3	-2	0	2	4
-16	14	20	24	28	30	34	38	-27	-10	-7	-4	-2	-1	1	3
-18	13	18	22	26	28	32	36	-28	-11	-8	-6	-3	-2	0	2
-20	12	16	20	24	26	30	32	-29	-11	-9	-7	-4	-3	-1	0
Dew point (°F)								Dew Point (°C)							

4.5.2.2 Desiccant Drying Method

4.5.2.2.1 We do not recommend the use of desiccant dryers unless very low dew points are required. Refrigerant dryers are normally the best choice since they are less expensive, require less maintenance, and are more reliable. For those few clinics requiring very low dew points, the following should be helpful. These dryers contain a desiccant material that adsorbs moisture from the compressed air by physical means. When the desiccant becomes saturated with water, it is reactivated by removing this moisture. Reactivation can be accomplished by two methods:

4.5.2.2.1.1 Heatless (or Pressure Swing) Method where between 5% and 20% of the previously dried compressed air is bled back through the desiccant in a controlled manner. Since the compressor must be sized larger to provide this purge air, this type of unit is expensive to operate.

4.5.2.2.1.2 Heat Reactivated Method where the desiccant is dried by heated room air. This method does not require the compressor to be oversized and is less expensive to operate than the heatless method. The initial cost of this system, however, is more than the heatless system.

4.5.2.2.2 To minimize conflict with the compressor's operation, two desiccant-filled cylinders are used. One cylinder dries compressed air, while the second one is reactivated. When the first cylinder becomes saturated with moisture, then the operating mode of the two cylinders is exchanged. These twin

cylinder systems can provide continuous air drying and are preferable to single cylinder systems (see Special Topic #4.6).

4.5.2.2.3 Desiccant drying media loses capacity with age and needs to be replaced approximately every 2 to 3 years. Access to the desiccant should be designed into the dryer to expedite desiccant replacement.

4.5.2.2.4 The three types of desiccant media commonly used are:

4.5.2.2.4.1 Activated alumina, which is liquid tolerant, can dry to a dew point of -40° C (-40° F). It has high adsorption capacity.

4.5.2.2.4.2 Silica Gel, which must be protected from liquid (usually by a layer of activated alumina), can dry to a dew point of -40° C (-40° F). It can have a chemical humidity indicator added (at about the 50% relative humidity, its color changes from blue for dry air, to pink for wet air).

4.5.2.2.4.3 Molecular Sieve can obtain dew points as low as -73° C (-100° F), but it is expensive and has low adsorption capacity.

4.5.2.2.5 Due to their physical method of moisture absorption, desiccant dryers will also capture other impurities in the compressed air, namely oil vapor. Unfortunately, once the oil has been adsorbed it cannot be removed from the desiccant. Thereafter, it does not capture moisture adequately and its effective life is reduced. When these dryers are used with lubricated compressors, an oil coalescing filter must be placed upstream of the dryer. Desiccant pellets break down to a fine abrasive dust with time; thus, an after-filter that removes particles larger than 1μm must be installed between the dryer and the clinic.

4.6 Comments on "Dental Air Compressors".

4.6.1 Many of the systems sold as "dental air compressors" have one principal advantage over the industrial compressors recommended in this document -- they are quiet. If a compressor must be placed near occupied rooms and the building cannot be modified for adequate sound control, one of the dental compressor packages is likely to be the best choice. Study the options carefully. The problems with many of the dental compressor packages are:

4.6.1.1 Compressors are single stage and suffer from the problems discussed previously in the compressor section.

4.6.1.2 High oil carry-over rates require careful monitoring of the oil level.

4.6.1.3 Compressors frequently use only one desiccant column. Compressor systems using only one desiccant column dry compressed air during the compression cycle and then regenerate the desiccant by the heatless method when the compressor stops. These single cylinder systems are extremely sensitive to high humidity, high temperatures and extended duty cycles since they only regenerate when the compressor is not running. This system must always have an aftercooler with an air/water separator and automatic drain before the desiccant column. To be sure there is enough time to regenerate the desiccant, these systems should be sized with a very low duty cycle, sometimes as low as 30%. These dryers are generally not able to maintain dew points below 2° C (35° F). The desiccant in the column must be replaced every 2 to 3 years.

4.6.2 Most of the dental compressor packages will not meet the air quality requirements specified in this document. Additional filters and air dryers may need to be added to bring them into compliance.

4.7 Comments on Air Operated Evacuation Systems. Wherever possible, central vacuum is preferable to an air operated evacuation system. Central vacuum systems produce better suction, do not produce septic aerosols in the DTR, and do not require an oversized compressor for their operations. Air operated evacuation systems should only be used where the facility design precludes the use of a central vacuum system.

5. CONCLUSIONS

5.1 As mentioned in the introduction, this report updates the information provided by USAFSAM-TRs 86-7 and 86-8. Major changes from or additions to these previous documents are:

5.1.1 Total compressor capacity increased to a minimum of 113 lmp (4.0 cfm) at 7 kg/cm^2 (100 psig) per DTR.

5.1.2 Clarified recommendation for lubricated compressors with proper oil coalescing filters.

5.1.3 A limit of 0.35 kg/cm^2 (5 psig) air line loss in building air lines.

5.1.4 Discussion of system air pressures.

5.1.5 Added selection checklist for compressed air systems.

5.1.6 Added an annual inspection checklist for the compressed air system.

5.2 Much of the information included in this report was taken from the results of a survey received from dental facilities worldwide. Whenever possible, a recommendation was made concerning a particular system or component. Table 3 is a summary of air compressor requirements for DTRs.

TABLE 3. AIR COMPRESSOR REQUIREMENTS FOR DTRs
(CUBIC FEET PER MINUTE)

NO. OF DTRS	REQUIRED CFM/LPM	MOTOR SIZE (HORSEPOWER)
1 - 3	2 - 6 57 - 170 LPM	0.5 - 1.5
4	7.2 204 LPM	1.5
8	11.2 317 LPM	3.0
12	16.8 476 LPM	5.0
16	22.4 634 LPM	7.5
20	28.0 793 LPM	7.5
24	33.6 952 LPM	7.5
28	33.6 952 LPM	7.5
32	38.4 1087 LPM	10.0
36	43.2 1223 LPM	15.0
40	48.0 1359 LPM	15.0
50	60.0 1699 LPM	15.0
60	72.0 2039 LPM	15.0
60 +	SEE NOTE 4	SEE NOTE 4

NOTE 1: 1 - 3 DTRs, 100% USE FACTOR, PROPRIETARY BUY

NOTE 2: ABOVE VALUES DO NOT INCLUDE DENTAL LAB AIR

NOTE 3: CFM REQUIREMENTS BASED ON 70% USAGE FOR LESS THAN 28 DTRs AND 60% USAGE FOR 28 OR MORE

NOTE 4: CALCULATIONS FOR MORE THAN 60 DTRs
NO. OF DTRs X 2.0 CFM X .60 = CFM REQUIREMENT
NO. OF DTRs X 57 LPM X .60 = LPM REQUIREMENT

NOTE 5: FOR M^3/MIN CARRY OUT LPM 3 DECIMAL PLACES TO LEFT
1087 LPM = 1.087 = 1.1 M^3/MIN

Part XV
Section D

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GLOSSARY

µM Micrometer; one-millionth of a meter.

acfm Average cubic feet per minute. This is flow rate stated by manufacturers which is the average flow rate when a compressor pumps a defined volume (usually the receiver) from atmospheric to a specified pressure. This value will be greater than the rated full-pressure capacity of the compressor.

aftercooler A device that cools compressed air immediately after compression to its final pressure. Air cooled aftercoolers are the most common type in dental facilities.

air receiver The air tank where compressed air is stored.

alternator An electrical device that controls the start-up and stopping of duplex air compressors. It helps to even out the mechanical wear on the two compressors.

ASME American Society of Mechanical Engineers. This society sets safety standards for mechanical systems.

AVS Air Venturi System. If the facility design allows for a central vacuum system, it is preferable to an Air Venturi System.

Base-mount Compressor Compressor system in which an electric motor and compressor are mounted on a base independent of the air receiver.

cfm Cubic feet per minute.

cim Cubic inches per minute.

DCA Dental Compressed Air.

dew point The temperature where water vapor will condense into liquid water if a mixture of air and water vapor is cooled at a constant pressure. The dew point is the temperature at which the actual vapor pressure equals the saturated vapor pressure, i.e., 100% relative humidity. The dew point of a sample of air will remain the same as the temperature of the air sample rises. See also Relative Humidity.

distance piece A connector and chamber between a wet sump and the compression chamber. The chamber has oil seals at both ends designed to prevent oil from migrating from the sump to the compression chamber. The connector transmits forces from the crank to the pistons through this space.

dry receiver An air receiver that stores air that has been fully dried.

DTR Dental Treatment Room

duty cycle A percentage value that is calculated by:

duty cycle=T_c X 100/(T_c + T_i)

T_c = Time Compressor is Compressing Air or Loaded

T_i = Time Compressor is not Compressing Air or Unloaded

FAD Free air Delivery, usually measured at 100° F.

HP Horsepower for compressor's electric motor.

helical-lob rotary compressor Another name for rotary screw compressor.

intercooler An air cooling device that is used between stages of a double stage compressor.

lag compressor The compressor that starts if the lead compressor is unable to provide enough air flow to meet the air demand.

lead compressor The first compressor that starts to supply compressed air when the air pressure drops below a preset value.

loading and unloading When a compressor is loading and unloading, the motor runs continuously and the supply of compressed air is limited by adjusting the compressor's valves.

lpm Liters per minute.

ppm w/w Parts per million by weight.

psi Pounds per square inch.

psia Pounds per square inch absolute. This is the air pressure above a complete vacuum.

psid Pounds per square inch difference. This term is usually used to measure air pressure loss across air lines or devices.

psig Pounds per square inch gage. This term refers to air pressure above atmospheric air pressure. Conversion to psia is: psia = psig + 14.7 psi.

relative humidity A measure of the degree of water vapor saturation in air. It is the ratio of the actual water vapor pressure to saturated water vapor pressure. As the temperature of a sample of air rises, its relative humidity will decrease.

scfm Standard cubic feet per minute.

single phase electricity An electrical circuit with only one alternating electrical wave form, characterized by having two wires (excluding ground).

single-stage compressor A compressor that compresses air from atmospheric to the final pressure in one compression cycle. Single-stage compressors are best suited for pressures of 80 psig and lower.

skid-mounted compressor An electric motor and compressor that are mounted on a skid (i.e. base) independent of the receiver. The receiver is located at a distance from the base-mounted compressor.

sump Space where the main crank and bearings operate. A "wet sump" indicates that a pool of oil is at the bottom of the sump and the movement of the main crank and bearings splashes oil up on the piston cylinders and rings lubricating them. A "dry sump" indicates that the sup lacks oil and that the main bearings are sealed with a small amount of lubricant.

TEFC Total enclosed fan cooled. TEFC motors are intended to be used in dusty environments but are not usually needed for DCA.

triple phase electricity An electrical circuit with three alternating electrical wave forms, characterized by three wires (excluding ground).

two-stage compressor A compressor that compresses air in two stages and cools the air between the stages. This type of compressor is more efficient for pressures above 5.6 kg/cm^2 (80 psig) than a single-stage compressor.

wet receiver A receiver storing compressed air containing water vapor which is passed through the air dryer to remove moisture.

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COMPANY ADDRESSES

Notes after each company are provided by the authors and are offered to provide some insight into their product and policies. Most companies will only provide prices for their products by written quote. Most of these addresses are for the corporate headquarters who will most likely refer you to a local dealer. The reader is advised to contact more than one vendor to get a range of prices. This listing is not intended to be all inclusive, nor is it a recommendation. A reader who is aware of additional manufacturers should feel free to investigate their product liens.

Balston, Inc.
703 Massachusetts Avenue
P O Box C
Lexington MA 02173
Phone: 1-800-343-4048

Specializes in air filters for special applications as sterile air, oil coalescing filters, etc. They do offer a unique small oil coalescing filter that could be used in the DTR.

Bauer Compressors Inc.
1328 Azalea Garden Road
Norfolk VA 23502
Phone: (804) 855-6006

Sells a complete line of rotary screw, lubricated and oil-free reciprocating air compressors.

Corken International Corporation
3805 N.W. 36th Street
Oklahoma City OK 73112
Phone: (405) 946-5576

Manufactures a complete line of nonlubricated air compressors.

Custom Vacuum
Den-Tal-Ez
P O Box 896
Valley Forge PA 19482
Phone: 1-800-845-8480

Sells small dental specific compressors (1, 2, 3 hp). These compressors are quiet, but expensive, and may need modification to meet this DCA Standard.

Hankison
Canonsburg PA 15317
Phone: (412) 745-1555

Sells a wide range of aftercoolers, air filters, desiccant air dryers, and refrigerated air dryers. Company's literature is very informative.

Ingersoll-Rand Air Compressors
P O Box 1126
Wall Street Station
New York NY 10005
Phone: 1-800-847-4041 or (212) 775-1395

Sells a wide range of reciprocating compressors (lubricated and nonlubricated), rotary screw compressors, aftercoolers, air dryers and air filters. Offers a number of products at a special Government rate. They are the most common supplier of dental air compressors for the Federal Services. Company's literature is very informative.

Kaeser Compressors
P O Box 7416
Fredericksburg VA 22404
Phone: (703) 898-5520

Sells air filters, air dryers, and rotary screw compressors.

Luckman Corporation
1930 Old York Road
Abington PA 19001
Phone: (215) 659-1664

Sells a small dental specific rotary vane compressor (2 hp). This compressor is quiet, but initially expensive, and may need modification to meet this DCA Standard.

Nash Engineering
1115 Goodnight Trail
Houston TX 77060-1112
Phone: (713) 821-9514

Specializes in water ring compressors (7.5 hp and larger). Company's literature is very informative.

Quincy Compressor
3501 Wismann Lane
P O Box C2
Quincy IL 62305-3116
Phone: -1-800-747-0547 ext 200 / (217) 222-7700

Sells a wide range of reciprocating compressors (lubricated and nonlubricated), rotary screw compressors, aftercoolers, air dryers and air filters. Offers lubricated reciprocating compressors to the Government at the wholesale rate if ordered from the company. Company's literature is very informative.

SIHI Pumps, Inc
303 Industrial Blvd
P O Box 100
Grand Island NY 14072
Phone: 1-800-828-6861 or (716) 773-2330

Specializes in water ring compressors (7.5 hp and larger)

Sullair
3700 East Michigan Blvd
Michigan City IN 46360
Phone: 1-800-348-2722 or (219) 879-5451

Sells rotary screw compressors, air filters, and air dryers. Their smaller rotary screw compressors (5, 10, and 15 HP) are listed on a GSA price schedule and are competitive with the lubricated reciprocating compressors.

Van Air Systems Inc
2950 Mechanic Street
Lake City PA 16423
Phone: (814) 774-2631

Specializes in aftercoolers, air dryers and air filters. Company's literature is very informative.

Wilkerson Corporation
P O Box 1237
Englewood CO 80150
Phone: (303) 761-7601

Specializes in aftercoolers, air dryers and air filters. Company's literature is very informative.

Zander Filter Systems Inc
5500 Oakbrook Parkway
Suite 110
Norcross Georgia 30093
Phone: (404) 446-3614

Specializes in air dryers, and air filters, including sterile air filters.

Zeks Air Dryer Corporation
Malvern Industrial Park
Box 396
Malvern PA 19355
Phone: 1-800-888-2323

Specializes in aftercoolers, air dryers and air filters.

Zurn
One Zurn Place
Box 2000
Erie PA 16512
Phone: (814) 452-2111

Sells a complete line of air filters

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DENTAL COMPRESSED AIR EQUIPMENT SELECTION CHECKLIST

Calculations:

1. Number of Dental Treatment Rooms
   _____ X 57 LPM (2.00 CFM) = _____
2. Number of Air Venturi Systems
   _____ X 27 LPM (4.50 CFM) = _____
3. Number of outlets in dental laboratory
   _____ X 7 LPM (0.25 CFM) = _____

4. If the value in #3 is ≥ 4.00, enter 4.00, or else enter value from #3 = _____

5. Add 1, 2, and 4 (Total LPM/CFM required per compressor) = _____
   Multiply value from #5 by usage factor ___ X 1.2

6. Size of air dryer needed = _____
   Multiply value from #6 by 57 LPM (2.00 CFM) ___X 2.0

7. Total air flow required for the DCA
   System at 7 kg/cm^2 (100 psig) = _____

AIR COMPRESSOR

Size: From #5 under calculations
Required options:

_____ Double-stage compressor (if reciprocating compressor)*
_____ Duplex compressors; each must provide the air flow from #6
_____ Control panel with alternator
_____ Low oil or high temperature shutdown switch (lubricated compressors only)
_____ Intercooler

_____ Aftercooler (only necessary if the compressor is 7.5 hp or larger)
_____ Aftercooler has moisture separator with automatic electric drain
_____ Aftercooler can cool within 11°C (20° F) of room temperature
_____ Aftercooler has less than 0.14 kg/cm^2 (2 psi) pressure drop at full air flow

_____ Low pressure alarm
_____ Air receiver is internally and externally rustproofed (galvanized preferred)

_____ Air receiver is ASME certified
_____ Air receiver has pressure gage
_____ Air receiver automatic electric drain
_____ Air shut-off valve

Additional things to consider:

_____ Will the compressor assembly fit through halls, doorways, and have at least 0.9 m (36 inch) of clearance on all sides when installed
_____ Order the correct motors to match your facility's electrical power supply (voltage, phase, and frequency)
_____ Three-phase motors are preferable to single phase motors
_____ If the elevation of your installation is over 1500 meters (5,000 ft), check with the manufacturer for special compressors and motors

Air Dryer

Size: From #6 under calculations.

Required options:

_____ Refrigerated air dryer **
_____ Can maintain dew point at or below 3° C (38° F) at 100 psig with room temperature at 38° C (100° F)
_____ Has no more than a 0.35 kg/cm^2 (5 psi) pressure drop during full air flow conditions
_____ Is noncycling
_____ Has a high temperature warning light
_____ Has outlet temperature gage
_____ Automatic electric drain

Additional item to consider:

_____ A general purpose oil filter may be needed before the dryer (if an oil-lubricated compressor is used)

Air Filters

Size: From #7 under calculations.

Requirements:

A. General Purpose Coalescing Filter (required on all systems)

_____ Less than .07 kg/cm^2 (1 psi) air pressure drop (when clean and dry) at air flow given in #7
_____ Removes particles larger than 1 μm
_____ Equipped with automatic drain (electric preferred)

_____ Differential pressure monitor

B. Final Coalescing Filter (required only on lubricated systems)

_____ Less than 0.14 kg/cm^2 (2 psi) air pressure drop (when clean and dry) at air flow given in #7
_____ Removes particles larger than 0.01 μm
_____ Removes oil carryover to less than 0.10 ppm w/w
_____ Equipped with automatic drain (electric preferred)
_____ Differential pressure monitor

C. Vapor Removal Filter (required only on oil lubricated systems)

_____ Less than 1 psi air pressure drop (when clean and dry) at air flow given in #7
_____ Removes oil carryover to less than 0.01 ppm w/w
_____ Will be fitted with a downstream tap for sampling air

Air Pressure Regulator

Requirements:

_____ Has an air pressure gage with a range of 0-10.5 kg/cm^2 (0-150 psig)
_____ Can handle air flow given in #7

Building Air Lines

Requirements:

_____ Will have no more than 0.35 kg/cm^2 (5 psi) pressure loss at the furthermost user during full flow conditions
_____ Smallest diameter is not less than 13 mm (0.5 inch)
_____ Rated at 10.5 kg/cm^2 (150 psig) working pressure
_____ Type "K" or "L" seamless copper tubing, washed and degreased
_____ Valves and fittings are wrought copper, brass, or bronze

* For a dental laboratory is the compressor will not be operated above 5.6 kg/cm^2 (80 psig) then a single stage compressor is acceptable.

** A desiccant air dryer is only acceptable if compressed air dew point must be kept below -7° C (20° F); see Special Section 5 for more information.

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SECTION D

SUGGESTED ANNUAL EXAMINATION OF THE DENTAL COMPRESSED AIR SYSTEM

The DCA System should be inspected annually by the dental staff together with those responsible for maintenance. The purpose is to familiarize the dental staff with their DCA System, review maintenance procedures accomplished during the past year, and identify equipment that should be replaced. Regular inspections can help identify and correct small problems before they cause work stoppages. Remember, a properly selected and maintained DCA System can last 20 to 30 years.

Specific instructions from the manufacturer take priority over these instructions.

Date of Inspection: Name of Inspectors:

Location of Inspection:

Disconnect Electrical Power Before Starting Inspection
When discharging air, wear safety glasses and stand clear of exhaust

Air Compressor

_____ Crankcase oil is at the correct level
_____ Oil and oil filter is changed at least once a year and recorded in the maintenance log
_____ Air intake filter is clean and replaced yearly
_____ Drive belts are in place and adjusted to the correct tension
_____ Operate drain valves manually' no more than a few ounces of water should be discharged from any valve
_____ Operate all safety valves manually
_____ Intercooler fins are free of dust and obstructions
_____ Test low air pressure alarm
_____ Check foundation bolts for tightness
_____ On reciprocating compressors the valves should have been removed and cleaned during the past year

Aftercooler

_____ Aftercooler fins are free of dust and obstructions
_____ Manually open drain valve; no more than approximately 60 ml (2 oz) should be discharged fro any valve
_____ Water-cooled unit should be checked for mud and scale accumulations

Reconnect electrical power for the rest of the inspection.

Air Compressors

_____ Perform pump up test *

_____ Listen for unusual sounds that may indicate problems

_____ Inspect all air lines, listening for leaks and testing with soap and water if necessary

Refrigerated Dryers

_____ Fins and openings are free of dust and obstructions

_____ Manually open drain valve; no more than a few ounces should be discharged from any valve

_____ Outlet air temperature gage setting is between 2-3° C (35-38° F)

_____ High temperature light is not on

Desiccant Dryers

_____ Check operating manual for inspection guidelines

_____ Desiccant should have been replaced within the last 3 years

Coalescing Filters

_____ While the clinic is using air, check the differential pressure monitors for clogged filters

_____ Manually open drain valves; no more than a few ounces should be discharged from any valve

Vapor Removal Filter

_____ Slightly crack open air sample tap; if there is a detectable odor, the cartridge needs replacement

* Performance Pump Up Test

1. Stop Compressors
2. Discharge all air from the DCA System
3. Close the sir receiver's shut off valve
4. Start compressor
5. Record time needed to raise air pressure from 0-7 kg/cm^2 (0-100 psig) ("pump-up time")
6. Open the air receiver's shut off valve
7. Compare pump-up time with last year's value or manufacturer's value. A substantial increase in time indicates that the compressor is in need of repair

Last year's pump-up time: _____ This year's pump-up time: _____

Part XVI

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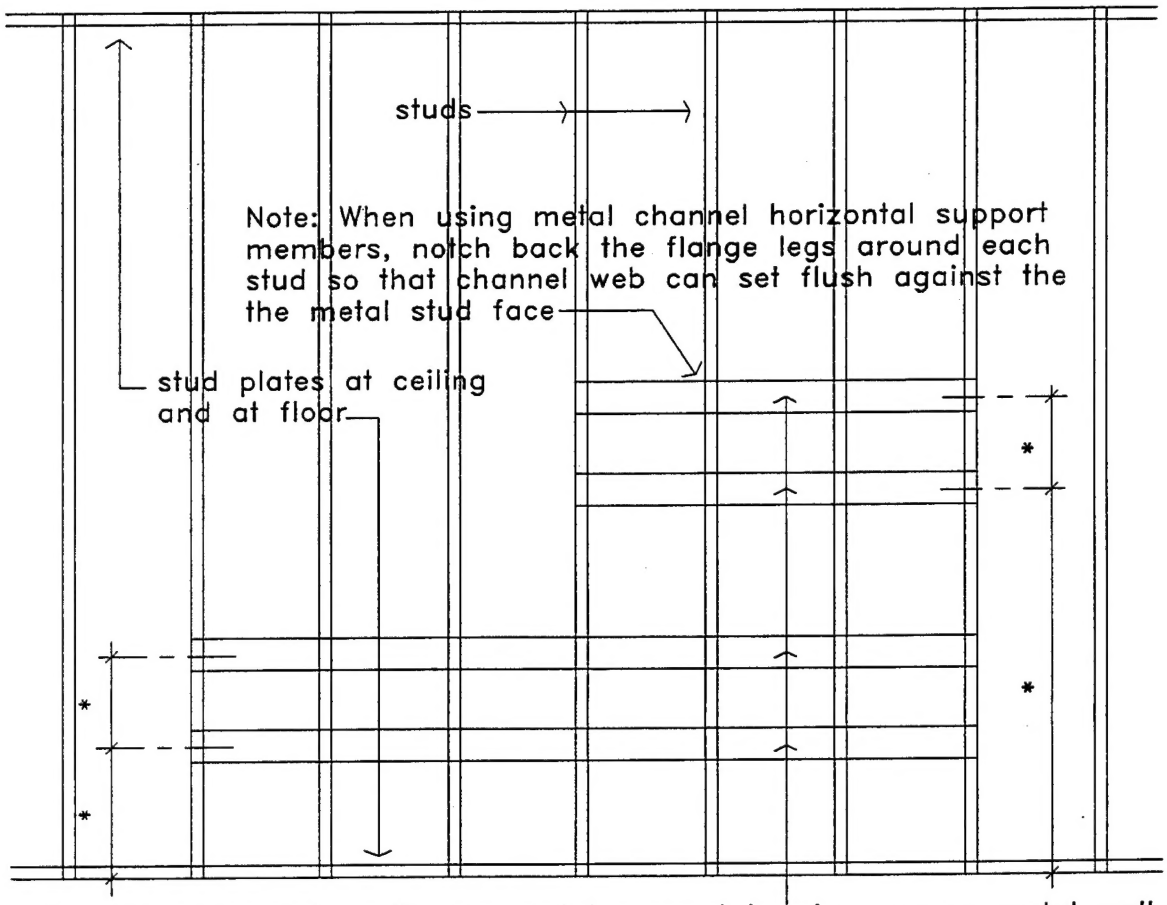
Appendix A



* Locate horizontal support members where recommended by manufacturers instructions or directions.

DTR Wall Elevation Showing Typical Dental Casework Support Bracing

Scale: 1/2"=1'-0"